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Residential Wood Combustion Study. Task 7. Indoor Air Quality

Quality

Green (Del) Associates, Inc., Woodburn, OR

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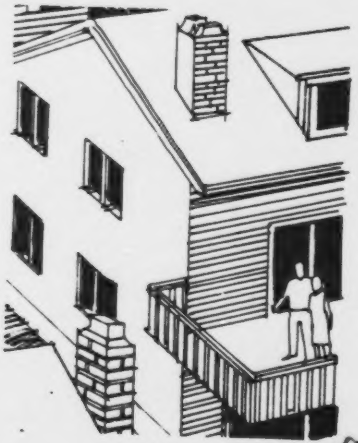
Residential Wood Combustion Study

Task 7
Indoor Air Quality



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Indoor exposure to particulate air pollution associated with residential wood combustion was studied in five typical Northwest homes during May, 1980. Particulate mass and polynuclear aromatic hydrocarbon (PNA) species were measured in each home prior to, and during wood appliance use to determine the degree to which indoor particulate mass and PNA concentrations increased. Air infiltration rate information typical of the homes included in the survey were obtained form the literature. Records of wood use and climatic conditions during the indoor sampling period were maintained. Experimental results are compared to other indoor air pollution studies on residential wood combustion and interpreted in relation to typical wood use during cold weather periods associated with greater wood burning activity. Program conclusions relative to appliance operations, design and maintenance are discussed.

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RESIDENTIAL WOOD COMBUSTION STUDY

TASK 7

INDOOR AIR QUALITY

RESIDENTIAL WOOD COMBUSTION STUDY

TASK 7

INDOOR AIR QUALITY

FINAL REPORT

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Under Contract No. 68-02-3566

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Region X
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October, 1982

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THEY ARE LISTED BELOW FOR YOUR CONVENIENCE.

EPA 910/9-82-089a	Residential Wood Combustion Study Task 1 - Ambient Air Quality Impact Analysis
EPA 910/9-82-089b	Task 1 - Appendices
EPA 910/9-82-089c	Task 2A - Current & Projected Air Quality Impacts
EPA 910/9-82-089d	Task 2B - Household Information Survey
EPA 910/9-82-089e	Task 3 - Wood Fuel Use Projection
EPA 910/9-82-089f	Task 4 - Technical Analysis of Wood Stoves
EPA 910/9-82-089g	Task 5 - Emissions Testing of Wood Stoves Volumes 1 & 2
EPA 910/9-82-089h	Task 5 - Emissions Testing of Wood Stoves Volumes 3 & 4 (Appendices)
EPA 910/9-82-089i	Task 6 - Control Strategy Analysis
EPA 910/9-82-089j	Task 7 - Indoor Air Quality

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VOLUME II

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ABSTRACT

Indoor exposure to particulate air pollution associated with residential wood combustion was studied in five typical Northwest homes during May, 1980. Particulate mass and polynuclear aromatic hydrocarbon (PNA) species were measured in each home prior to, and during wood appliance use to determine the degree to which indoor particulate mass and PNA concentrations increased. Air infiltration rate information typical of the homes included in the survey were obtained from the literature. Records of wood use and climatic conditions during the indoor sampling period were maintained.

Experimental results are compared to other indoor air pollution studies on residential wood combustion and interpreted in relation to typical wood use during cold weather periods associated with greater wood burning activity. Program conclusions relative to appliance operation, design and maintenance are discussed.

EXECUTIVE SUMMARY

Recent increases in the use of residential wood combustion appliances and home weatherization have focused new concern on public health risks associated with indoor particulate air pollution from wood stoves. The purpose of Task 7 was to develop a better understanding of the concentration of indoor particulate and polynuclear aromatic hydrocarbons (PNA) during appliance use, thereby providing a basis upon which future indoor exposure levels can be assessed.

The program design consisted of measurement of aerosol mass and PNA concentrations in five typical Northwest homes during a 5-day period of wood stove use. Measurements during a similar time period within which the appliances were not used served to provide a measure of the increase in aerosol and PNA concentration associated with wood stove use. Houses selected for study included a newer tract home, a weatherized, airtight home built in 1974, an older home built in 1948, a moble home and an older rural home built in 1930. Only non-smoker homes with wood stoves were studied. Air infiltration rates typical of 4 of the homes were obtained from the literature. No information for mobile home air exchange rates was found, however.

Results from the sampling program indicated that, within the limits of experimental error, there was no significant increase in the concentration of aerosol mass or PNA concentration during appliance use in four of the five homes. Significant increases in mass and PNA levels were, however, found in one home equipped with a wood stove that leaked smoke into the room during charging and/or from leaks in the flue system. Concentrations of benzo(a)pyrene (B(a)P) found in this home during stove use were equivalent to B(a)P exposure associated with smoking approximately 10 cigarettes per day (lower limit estimate). Because wood use during the sampling period was about 25-60% of that typically used during the colder winter months, program results cannot necessarily be considered representative of periods of typically heavier wood use.

The program conclusions have identified the importance of proper wood stove installation, maintenance and operation to prevent excessive fugitive emissions which is of key importance to indoor air quality. The potential for public health risk associated with indoor fugitive smoke emissions is likely to become increasingly important as air infiltration is decreased by home weatherization and the use of wood burning appliances becomes more popular. Current information establishing the number of wood burning households with leaky stoves is not available upon which to form an assessment of public health risk.

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1.0 INTRODUCTION

The use of wood as a residential space heating fuel has increased significantly over the past few years. Figure 1 illustrates the rapid growth in the sales of wood burning appliances over the past decade. Because of the increasing popularity of wood burning appliances and the current emphasis on energy conservation (and attendant reduction in air infiltration), occupants of homes that heat with wood are likely to be exposed to fugitive smoke emissions that can represent an important health risk. This potential problem is especially important to the Pacific Northwest where approximately 50% of the homes rely on wood fuel to provide at least a portion of their heating requirements. An understanding of the indoor air pollution aspects of the Residential Wood Combustion (RWC) problem is important to those promoting the expanded use of wood for space heating.

2.0 PROGRAM PURPOSE

The purpose of Task 7 is to develop (a) better understanding of the level of respirable particulates in representative homes during periods of wood burning and (b) an assessment of the concentration of carcinogenic polynuclear aromatic hydrocarbon (PNA) compounds found during appliance use.

An individual's total exposure can be separated into indoor-home, indoor-work and outdoor environmental exposures. Potential pathways for exposure to hazardous air pollutants are illustrated in Figure 2. Although the entire exposure to pollutants from wood-burning appliances is of interest, only the indoor environment pathway will be assessed in this study. Polynuclear aromatic (PNA) compounds are of primary concern because of their abundance in RWC emissions and their carcinogenic nature. Many of the PNA compounds (such as benzo(a)pyrene) have been classified as carcinogenic and have historically been used as an indicator of other carcinogenic agents.

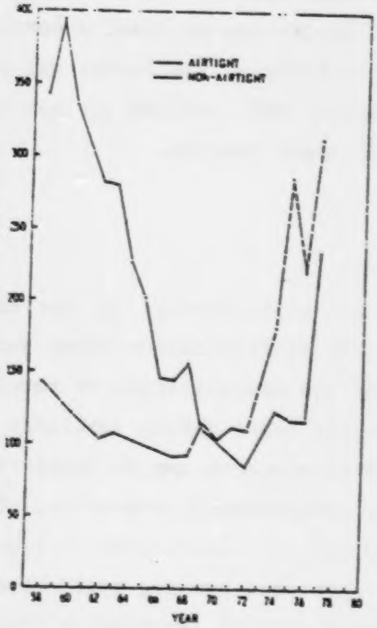
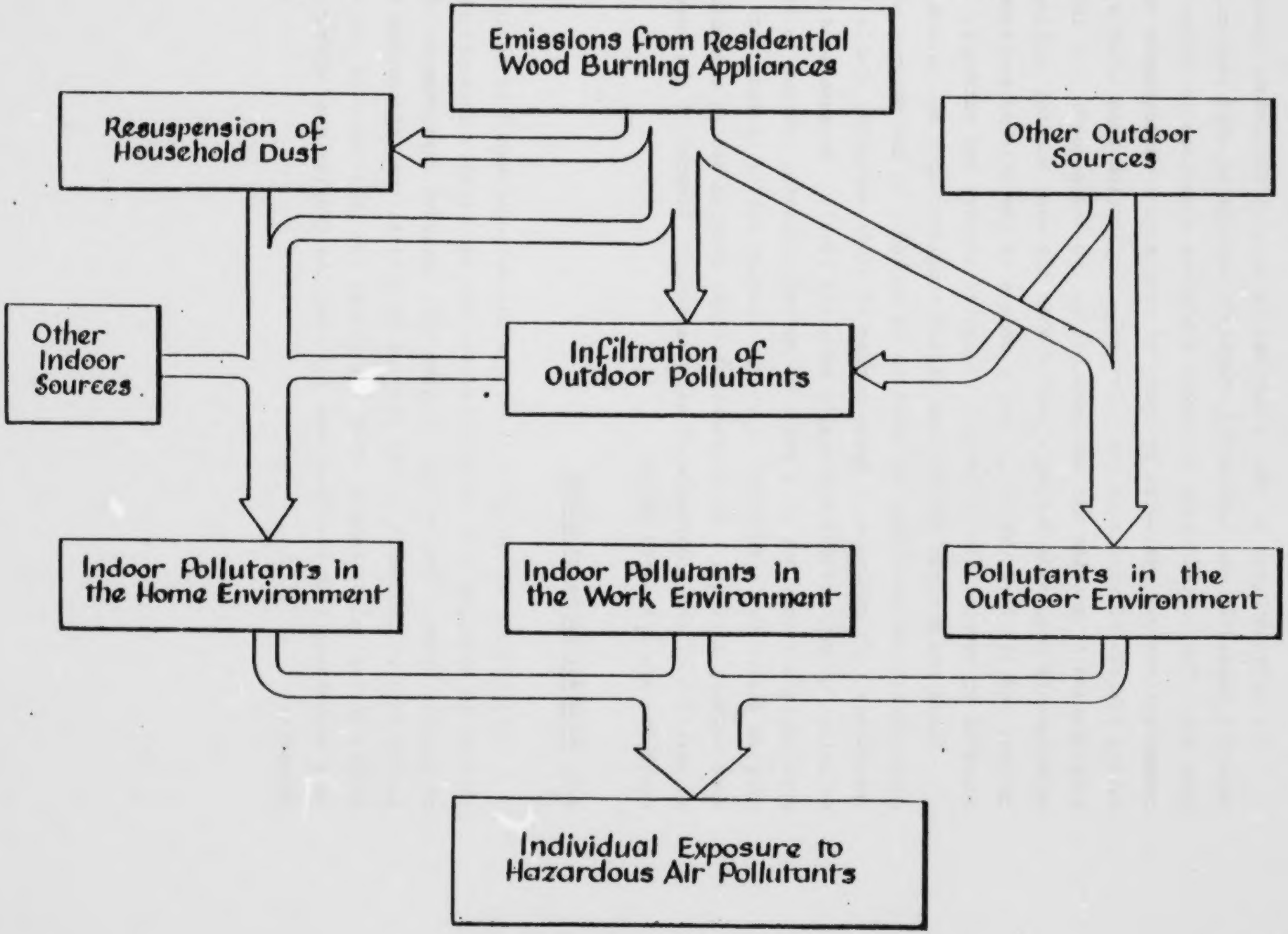


Figure 1 United States production of wood burning stoves

Figure 2

Pathways of Human Exposure to Hazardous Air Pollutants from Residential Wood Burning Appliances


Emissions from Residential Wood Burning Appliances
Resuspension of Household Dust
Other Outdoor Sources
Other Indoor Sources.
Infiltration of Outdoor Pollutants
Indoor Pollutants in the Home Environment
Indoor Pollutants in the Work Environment
Pollutants in the Outdoor Environment
Individual Exposure to Hazardous Air Pollutants

3.0 PROGRAM DESIGN

The approach used in this study was to measure the indoor concentration of selected hazardous and indicating chemicals associated with particulate emissions from RWC. The contribution of direct appliance emissions to indoor concentrations was evaluated by means of comparative measurements made before and during periods of appliance use. Aerosol contribution associated with infiltration of outside air was assessed by two techniques: (1) indoor measurements were made during a period when the wood burning appliances were not in use, and (2) lead, which is nearly unique to the outdoor environment, was measured on samples simultaneously collected indoors and outdoors.

Since the program results are highly dependent upon the nature of the indoor environment, the selection of homes to be included in the program were of central importance. In addition, a large number of other variables (Table 1) can affect pollutant concentrations and health exposure levels. Because wood burning appliances are only one of a group of aerosol emission sources in the home, the program design was structured to obtain samples during periods with and without wood burning activity. Development of other program design elements required an analysis of the importance of each variable. Several of the more critical variables are discussed below.

3.1 Home Air Exchange Rates

Infiltration of outside air to the indoor environment is of critical concern in assuring that program results can be properly interpreted and representative of typical homes. The initial program plan included measurements of five indoor home environments to (a) provide representative information of exposure levels in typical Northwest homes (b) reduce the importance of air exchange rate measurements in the study and (c) keep the program cost within available resources.

TABLE 1

PRINCIPAL VARIABLES ASSOCIATED WITH INDOOR AIR POLLUTION FROM WOOD-BURNING APPLIANCES

- APPLIANCE - Brand and Model
- FUEL
    - Species
    - Moisture content
    - Size
    - Aging period
- APPLIANCE OPERATION
    - Kindling and starting procedure
    - Fuel loading frequency and method
    - Combustion rate
    - Combustion temperature
    - Special manufacturers operating instructions
- HOUSE
    - Air exchange rates
    - Structural differences between homes
        - Insulation
        - Storm windows
        - Ventilation systems
        - Internal air volumes
        - Location of wood burning appliance
        - Chimney design
- HOUSEHOLD ACTIVITIES
    - Family size and age
    - Socioeconomic class
    - Average household occupancy per day
    - Length of appliance use
    - Percent of space heating requirements supplied by appliance
    - Behavior patterns, e.g., cooking, hobbies, smoking, ventilation, temperature preferences, etc.
- METEOROLOGICAL VARIABLES
    - Wind velocity - air exchange rate
    - Temperature - fuel combustion rate
    - Relative humidity - aerosol chemistry and physics
    - Low level inversion conditions - down draft

Air exchange rate measurements were not made because flucuations in air infiltration due to weather conditions, ventilation fan use, window and door use and other parameters reflected in a single short term measurement would be of little value. Occupant behavior and structural artifacts are particularly significant when comparing homes representing the spectrum of structural types and socioeconomic groups. In addition, extensive SF_6 tracer infiltration studies are typically able to provide results reproducible to only ± 50%.[2] For these reasons, and because of limited resources, air exchange rate measurements were not made. Instead, a literature search was undertaken to provide estimates of infiltration rates typical of the homes included in this study.

A recent compilation of published data estimaced that the average air exchange value for 224 homes during the winter was .67 air changes per hour (ach) with a standard deviation of .48 ach.[4] Based on this survey, relative air exchange rate ranking can be made based on structure, insulation and occupancy using literature values for similar home types. Table 2 summarizes air exchange rate measurements made for homes of similar age, construction and floor area as those used in this study. Information on air exchange rates for mobile homes similar to that included in the study was not available. Older uninsulated homes clearly fall at the high end of the air exchange rate range, whereas new energy efficient (well sealed and insulated) homes are grouped at the low end. In this study, an effort was made to select homes with approximately the same number of occupants to reduce potential variability in air exchange rates between homes.

A qualitative measure of the actual air exchange rate is provided by an analysis of the lead content of indoor and outdoor air particulate samples taken simultaneously. Since no known lead sources have been found in typical homes, the intrusion of lead-enriched aerosol from outdoor sources (leaded auto exhaust) can provide a measure of the air exchange rate. As, for example, the ratio of indoor to outdoor Pb approaches 1.0, the air exchange rate should also increase. Low indoor/outdoor ratios indicate low exchange rates due to particle deposition on interior surfaces. The indoor/outdoor Pb ratio also provides an indication of the upper limit of outdoor wood appliance emission contribution. The absolute Pb values are indicative of the distance to local traffic sources.

Table 2

Typical Air Infiltration Rates
For Survey Homes

House Number	House Type	Lowest ACH Rank Order	Construction Date	Floor Area (m^2)	Average Literature Value[3]: Construction Date	Average Literature Value[3]: Floor Area (m^2)	Average Literature Value[3]: Air Changes/hr mean ± std. dev.	Average Literature Value[3]: No. of Homes Tested
1	Older Home	3	1948	156	1950's	118	0.600 ± 0.040	2
2	New tract Home	1	1940/1970[1]	158	1950's	114	0.338 ± 0.110	13
3	Airtight Home	2	1974	135	1977	115	0.556 ± 0.133	5
4	Mobile Home	-	1975	88	-	No Available Data		-
5	Rural Home	4	1930	56	1929	105	1.140 ± 0.340	2

Notes:
[1] 1970 Addition to Home Constructed in 1940
[2] Literature values are for frame homes - not mobile homes
[3] Reference 4

3.2 House Selection Criteria

Houses selected for inclusion in the field program were selected on the basis of the criteria listed in Table 3. All were selected within the same airshed to assure some uniformity in outdoor air quality conditions. Key criteria for selection included (a) an absence of smokers in the household, (b) house type classified into one of the five groups chosen for study, (c) the presence, and established use, of a wood burning appliance, (d) selected occupant characteristics, (e) willingness to participate in the study, and (f) an absence of unusual combustion practices within, or adjacent to, the house. Backyard burning was considered an important emission source considered within the last criteria. Figure 3 describes potential sources and causes of wood smoke to the indoor air quality which were considered in the house selection process. In addition, the home types selected (Table 3) were intended to be representative of a cross section of Northwest homes. Table 4 summarizes the characteristics of the houses included in the field program. Figure 4 shows the house locations within Metropolitan Portland. Figure 5 illustrates the ground level floor plan of each house, the location of the wood burning appliance and the sampler.

Prior to initiation of the sampling period, information regarding the program and its purpose were distributed to home occupants, as were study instructions, house information sheets and daily data sheets describing wood stove operation, sampling information, weather and unusual events that may have influenced sample collection.

3.3 Wood Characteristics

An important consideration in developing the program design was control of the species and amount of wood burned in each household. A uniform lot of Douglas Fir firewood was purchased and supplied to each household in bundled, pre-weighed lots to insure that (a) accurate information on the amount of fuel burned could be obtained, (b) fuel consistency was maintained between households, and (c) variations in emission chemistry between homes could be minimized to the extent reasonably practicable. Moisture content measurements of the fuel varied

TABLE 3

HOUSE, APPLIANCE AND OCCUPANCY CHARACTERISTICS USED TO SELECT HOMES TO STUDY INDOOR AIR POLLUTION FROM WOOD-BURNING APPLIANCES

I. HOUSE TYPE - An attempt will be made to select one home from each of the following five categories. Additionally, at least one home will be from a rural area.

- An older home
- A newer tract home
- A mobile home or prefabricated home
- A low income home
- A tight home (energy efficient)

II. HOUSE CONSTRUCTION FEATURES WHICH MIGHT CONTRIBUTE TO HIGH INDOOR POLLUTION LEVELS (TABLE 1)

III. HISTORICAL USE OF APPLIANCE (PRIMARY/SECONDARY, YEARS IN USE, ETC.)

IV. APPLIANCE - TYPICAL COMMERCIALLY AVAILABLE STOVE AND CHIMNEY INSTALLED ACCORDING TO MANUFACTURERS SPECIFICATIONS

V. OCCUPANTS CHARACTERISTICS

- Family of three or more individuals (preferably at least one child)
- 80 to 90% occupancy over a typical week
- No indoor combustion sources other than wood burning appliance
- High level of interest in study
- Willingness to conform to minor restrictions during the study period
- No smokers

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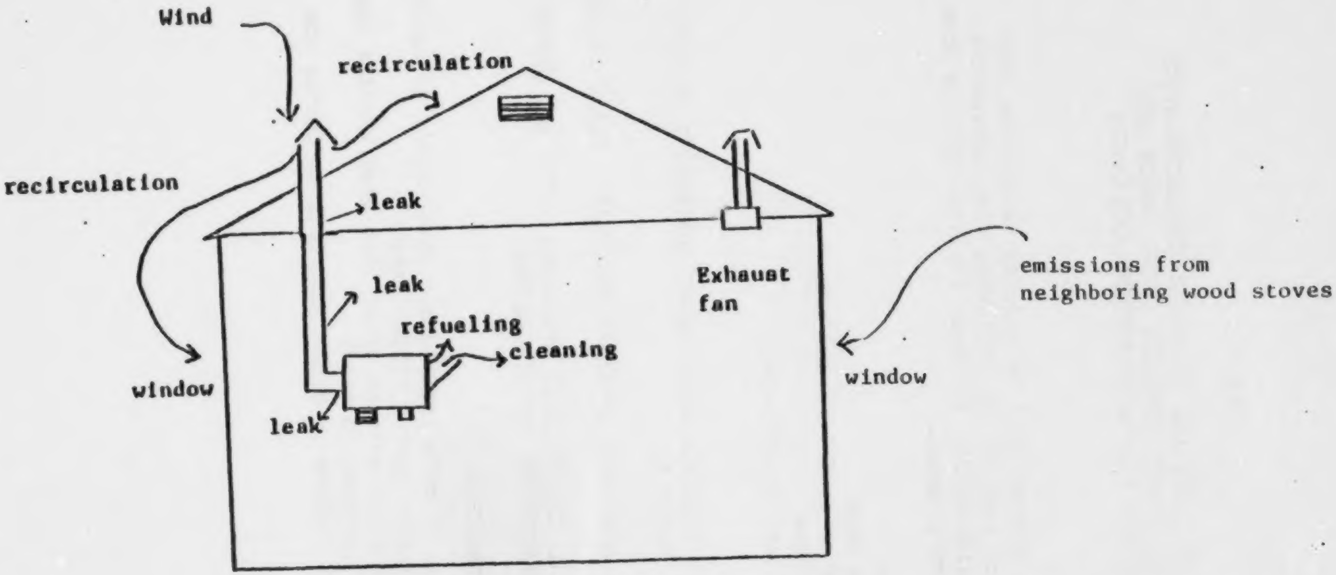
POTENTIAL SOURCES AND CAUSES OF WOOD BURNING APPLIANCE EMISSIONS TO THE INDOOR ENVIRONMENT


Wind
recirculation
recirculation
leak
leak
refueling
cleaning
leak
window
Exhaust fan
emissions from neighboring wood stoves
window

DURING USE

- Exhaust fan in house creates negative household pressure
- A puff of smoke may be drawn into room during refueling
- Leaks in stove and/or chimney
- Recirculation
- Neighbors appliance emissions

NOT IN USE

- Vapors from condensate deposited in chimney
- Resuspension of dust

DURING CLEANING

- Chimney cleaning
- Removal of ash from stove

FIGURE 3

Table 4

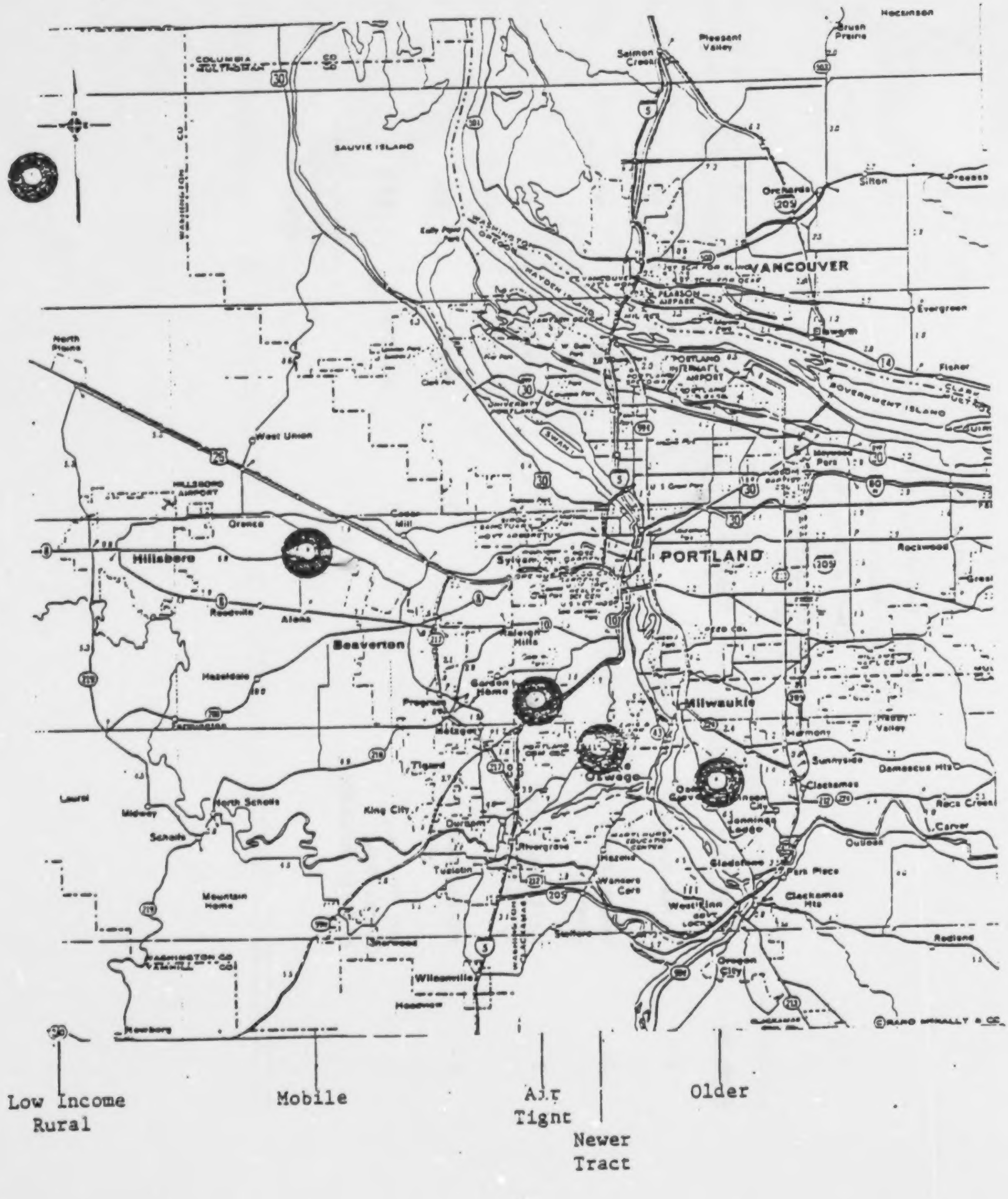
Indoor Residential Sampling
Residential Wood Combustion Study
(May 8-20, 1981)
House Characteristics

Home No.	House Type	Square Feet	No. Occupants	Wood Stove	Wt. of Wood Burned (Kg)	Avg. Mass of Wood Burned/day
1	Older Home	1680	10	Orley	89	18 kg/day
2	Newer Tract Home	1700	4	Fisher	97	19.5 kg/day
3	Well Insulated, Air tight home	1450	3	Earth	87	17.5 kg/day
4	Mobile Home	950	3	Arrow	29	5.8 kg/day
5	Low Income, Rural Home, Poorly Insulated	600	3	Ulefos	25	10.7 kg/day
					Average Rate of Wood Use During Survey	14.5 kg/day

Figure 4

Residential Wood Combustion

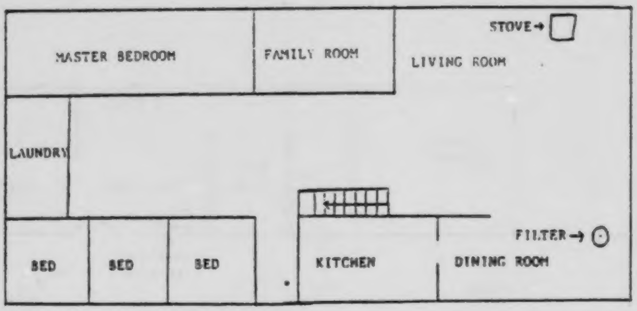
Study House Locations



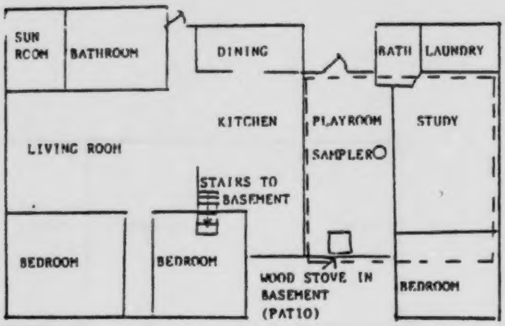
Low Income Rural
Mobile
Air Tight
Newer Tract
Older
PORTLAND
VANCOUVER
Hillsboro
Beaverton
Milwaukie
Oregon City
Sauvie Island
Tigard
Oswego
©RAND McNALLY & CO.

Figure 5

Survey Home
Floor Plans

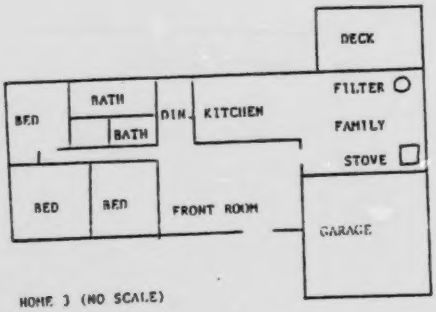

MASTER BEDROOM
FAMILY ROOM
LIVING ROOM
STOVE→
LAUNDRY
FILTER→
BED
BED
BED
KITCHEN
DINING ROOM

N ⟵ HOME 1 FLOOR PLAN


SUN ROOM
BATHROOM
DINING
BATH
LAUNDRY
KITCHEN
PLAYROOM
STUDY
LIVING ROOM
SAMPLER
STAIRS TO BASEMENT
BEDROOM
BEDROOM
WOOD STOVE IN BASEMENT (PATIO)
BEDROOM

N ⟵ HOME 2 FLOOR PLAN (NO SCALE)

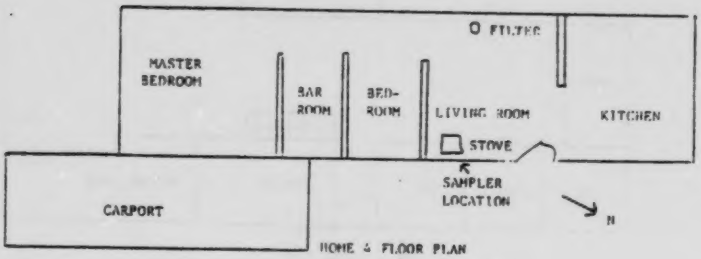
NOTE: AREA ENCLOSED IN HASHED LINE IS THE BASEMENT WHERE THE WOOD STOVE AND SAMPLER WERE LOCATED.


DECK
FILTER
BATH
BED
BATH
DIN.
KITCHEN
FAMILY
STOVE
BED
BED
FRONT ROOM
GARAGE

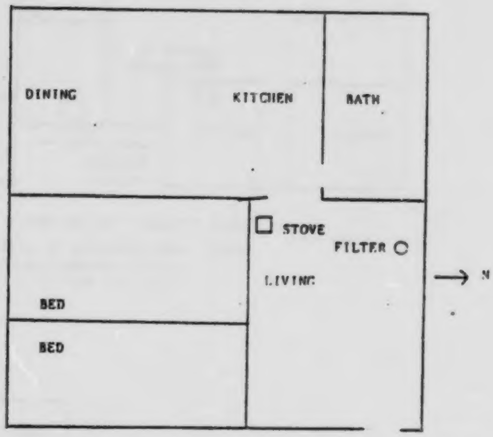
HOME 3 (NO SCALE)

Figure 5

Survey Home
Floor Plans


FILTER
MASTER BEDROOM
BAR ROOM
BED-ROOM
LIVING ROOM
KITCHEN
STOVE
SAMPLER LOCATION
N
CARPORT

HOME 4 FLOOR PLAN


DINING
KITCHEN
BATH
STOVE
FILTER
LIVING
N
BED
BED

HOME 5 FLOOR PLAN (NO SCALE)

between 20 and 30%. The amount of wood consumed per home during the burning period was found to range from 25 to 97 kilograms. Douglas Fir was chosen as it is indigenous to the Pacific Northwest and a commonly used fuel. Kindling, combustion rate and uniform starting instructions were provided to each household to minimize house to house variations in appliance operating conditions.

3.4 Meteorological and Space Heating Variables

Since personal exposure and indoor air quality conditions are dependent on the extent and duration of wood stove (or fireplace) use, collection of local climatological data (temperature, heating degree days and wind speed) is helpful to place the data in proper perspective relative to peak heating periods. Table 5 summarizes homeowner RWC appliance use during the wood burning period while Table 6 summarizes the meteorological conditions during the sampling period. Volume II is a compilation of appliance use in each home.

Weather conditions during the burning period (May 14-20, 1981) may be characterized as a period of moderate temperatures, light rain and cloudy skies. Since the total heating degree day value for the burning period was only 66, as compared to a typical peak 7 day period in February, 1981 of 198, space heating demand during the May burning period is not representative of "worst case" heating demand conditions during cold weather episodes.

Comparison of the rate of wood use per household during the indoor sampling period to use during a period of cold weather (February, 1981) helps to place the sampling results into the proper perspective. Results from the 1981 wood use survey conducted in Portland, Seattle and Spokane provided extensive information on the quantity of wood burned in wood stove households. Table 7 summarizes results of the survey for the month of February, 1981, a typical period of high space heating demand. (Note that for each city the survey area consisted of one-square mile of a residential neighborhood located near an ambient air sampling syste[illegible] consequently, although the wood use values are believed to be typical of a high demand period, the data must be used with caution.)

Table 5

Burning Period Record Summary

Home No.	Date	No. Times Refueled	Wood Use (Logs)	Burning Start (Estimated)	Period End (Estimated)	Comments
1	May 14	ND	ND	6:43 AM	ND	Overcast; vacuuming house
	May 15	Many	ND	6:50 AM	ND	
	May 16	ND	ND	8:00 AM	1:00 PM	Overcast
	May 17	ND	5	8:10 AM	ND	Overcast
	May 18	ND	ND	7:05 AM	ND	Rainy
	May 19	ND	ND	ND	ND	
2	May 14	2	3	5:30 PM	ND	Hot start up
	May 15	3	3½	4:15 PM	1:00 AM	Hot start up
	May 16	2	3	12:50 PM	9:00 PM	Hot start up
	May 17	2	4	4:30 PM	1:00 AM	Hot start up
	May 18	1	2	6:00 PM	Midnight	Hot start up
3	May 14	0	2	4:00 PM	8:00 PM	Hot start up
	May 15	0	1½	8:30 PM	9:30 PM	
	May 16	0	3	10:00 AM	1:30 PM	
	May 17	0	3	10:00 AM	2:30 PM	
	May 18	0	2	4:00 PM	7:30 PM	
4	May 14	3	2	6:00 PM	2:00 AM	Smoke downwash outside of the house during startup
	May 15	2	2	9:00 PM	Midnight	Smoke in room during refueling
	May 16	-	No Burning	-		
	May 17	3	2	8:00 PM	Midnight	
	May 18	2	2	8:15 PM	Midnight	Smoke haze outside
	May 19	2	3-4	6:00 PM	3:00 AM	
5	May 14	0	ND	1:00 PM	4:00 PM	Small fire
	May 15	1	2	9:00 AM	9:00 PM	
	May 16	2	2	9:30 AM	ND	
	May 17	2	2	Noon, 8 PM	2:00 AM	
	May 18	0	½	8:00 AM	ND	
	May 19	3	2	9:00 AM	ND	

ND - No Data

Table 6

Residential Wood Combustion
Indoor Sampling Program

Climatological Conditions Summary*

Day	Temperature (°F) Maximum	Minimum	Average	Degree Days Heating (Base 65° F)	Average Wind Speed (MPH)	Sunshine (% of Possible)	
8	68	43	56	9	8.9	80	No Burning Period
9	65	50	58	7	13.9	88	
10	66	45	56	9	10.4	92	
11	66	49	58	7	9.3	87	
12	76	42	59	6	5.7	92	
14	64	48	56	9	7.2	62	Burning Period
15	56	45	51	14	7.5	51	
16	63	47	54	11	7.4	78	
17	64	50	57	8	7.1	62	
18	63	52	58	7	6.7	56	
19	60	51	56	9	4.8	55	
20	61	52	57	8	6.5	49	

* NWS Station, Portland Airport

Table 7

Summary of
Wood Use For
Households with Wood Stoves
(February, 1981)

	Portland	Seattle	Spokane
Cords Burned (Mean)†	0.52 ± 0.59	0.43 ± 0.36	0.89 ± 1.02
Hours of Operation (Mean)	231 ± 195	219 ± 1±9	310 ± 225
Kg burned/day (8 hours)*	23	21	31
Kg burned/day (15 hours)*	45	39	58
Kg burned/day during indoor Sampling period	14.5**		

* Estimate assuming 20% moisture content Douglas Fir

† Based on wood use survey results, Task 2B

** Average rate of wood use, (see Table 4)

The quantity of wood burned per day during the indoor sampling period (Table 4) was approximately 60% of the 8 hour wood use rate identified during the February wood use survey (Task 2B) in Portland.

Personal exposure and indoor aerosol concentrations reported in this study should, therefore, be considered in light of the moderate weather conditions and fuel use that occurred during the sampling period.

4.0 SAMPLING AND ANALYTICAL DESIGN

Air sampling was conducted in each home using low volume samplers operating for a 24 hour period at a flow rate of 70 lpm. The inlet cut point of the sampler is approximately 30 μm, mass median aerodynamic diameter. The sampler intake was located at a height of 1 m above the floor and no closer than 2 m from the home's wood stove. Samples were taken on 47 mm glass fiber filters which were weighed before and after sampling* to determine the mass of aerosol

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* Filter weights include a mean correction of 12% to account for quartz fiber losses caused by adherence to the filter holder gasket.

captured. Following weighing, the filters were frozen to minimize possible PNA losses and shielded from sunlight. Sampling changing and records of air volume sampled were maintained by the homeowner. Each sampler's flow rate was calibrated prior to each series of home measurements.

Following gravimetric analysis, each of the ten 24 hour samples collected in each household during the burning and no burning periods were submitted for PNA analysis by gas chromatography/mass spectroscopy. The organic fraction of the samples were first extracted using standard Soxlet techniques, followed by specie separation on an alumina column. The ten composite samples (5 burn, 5 non-burn) thus formed on the average represent the particulate material contained in 500 m^3 of indoor air. Seven PNA's were selected for quantification based on their presence in wood smoke as determined from previous studies and/or based on their carcinogenic properties. The compounds selected were: fluoranthene, pyrene, benz(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene and benzo(ghi)perylene.

As noted above, an outdoor sampler was collocated at each home and run simultaneously with the indoor sampler for one 24 hour period to assess lead levels within, and outside of, the house. These samples were analyzed by X-ray Fluorescence. Figures 6 and 7 show the appearance and location of the indoor and outdoor sampling systems, respectively. A description of the project quality assurance plan is found in Appendix A. Raw data from the field program is included in Volume II.

5.0 PROGRAM RESULTS

Tables 8 and 9 present the results of the average mass measurements and PNA results during burning and no-burning conditions. Table 8 also lists results of indoor and outdoor lead concentrations, and the ratio between the two values as an indicator of outside air intrusion.

Results from the sampling program suggest that, with the exception of house number 1, differencesin the indoor air quality measurements for average aerosol mass and PNA concentrations as a result of wood appliance use were within the uncertainty of the measurements. This finding must be tempered with the understanding that the amount of wood burned in the homes during the test was 50% to 60% of that likely to be burned during cold weather conditions (average actual wood use was 6 hours per day during the sampling period). Indoor/outdoor lead measurements indicate that homes 1, 2 and 3 had significantly less air

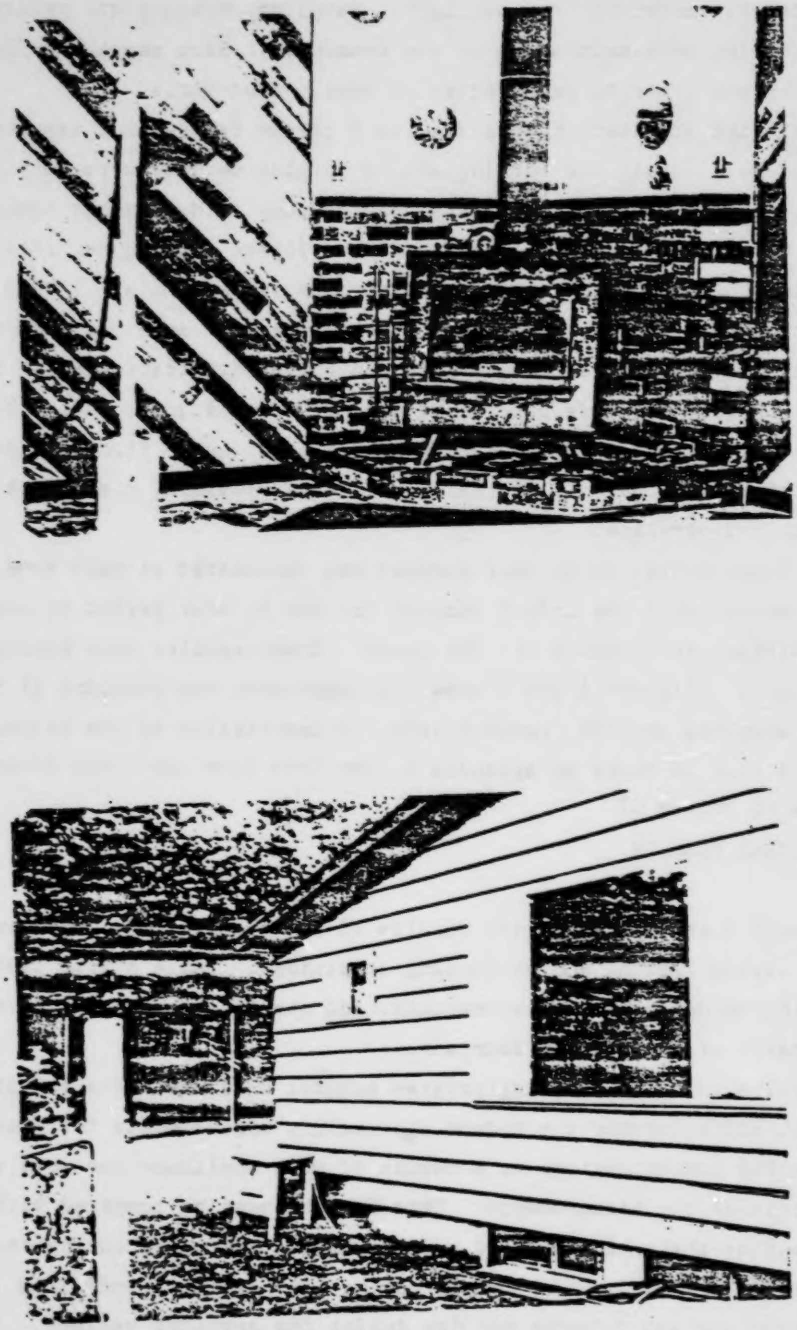

Figure 6 Indoor sampling system. Top figure is indoor inlet. Bottom figure is pump housing.

Figure 7 Co-located outdoor sampling system.

Table 8

Residential Wood Combustion
Indoor Sampling Program

-Summary of Analytical Results for Mass and Lead-

		Average Burn ($\mu g/m^3$)			Lead ($\mu g/m^3$)			
Home Number	Home Type	No-Burn (A)	Burning (B)	Difference (B-A)	Indoor (C)	Outdoor (D)	Ratio C/D	Average Mass of Wood Burned Per Day (Kg/day)
1	Older Home	50.5	73.6	23.1	5.05×10^{-2}	1.10×10^{-1}	.45	18
2	New Tract Home	16.5	23.0	6.5**	3.83×10^{-2}	8.04×10^{-2}	.47	19.5
3	Airtight Home	18.7	19.5	0.8**	7.54×10^{-2}	1.95×10^{-1}	.38	17.5
4	Mobile Home	32.9	38.6†	5.7**	2.42×10^{-2}	2.65×10^{-2}	.91	5.8
5	Rural Home	*	77.4†	-	2.82×10^{-2}	2.94×10^{-2}	.96	10.7

* Insufficient data
† 5 day average based on 4, 24 hour filters
** Statistically Insignificant at 95% CI

Table 9

Residential Wood Combustion

Indoor Sampling Program

-Summary of PNA Composite Results (ng/m^3)-

Home Number	Fluoranthene		Pyrene		Benz(a)anthracene		Benzofluoranthenes†		Benzo(a)pyrene		Dibenzanthracenes†		Benzo(ghi)perylene	
	No-Burn	Burn	No-Burn	Burn	No-Burn	Burn	No-Burn	Burn	No-Burn	Burn	No-Burn	Burn	No-Burn	Burn
1	0.1	1.4	0.2	3.0	-*	41.3	0.3	51.3	-	26.3	-	2.4	-	14.9
2$^{(A)}$	0.3	0.3	0.8	0.7	0.2	0.3	0.2	0.4	0.1	0.3	-	0.2	-	0.6
3	0.1	0.1	0.1	0.1	-	0.05	0.05	0.4	-	0.2	-	0.2	-	0.3
4	0.3	0.2	0.4	0.7	0.1	0.2	0.4	0.6	0.2	0.3	0.3	0.2	0.4	0.5
5$^{(B)}$	0.2	0.1	0.3	0.3	-	-	-	-	-	-	-	-	-	-

* Blank values indicate specie concentration below minimum detection limit.

† Benzo(b)fluoranthene and dibenz(a,h)anthracene were not completely resolvable from their isomers, and results were reported as benzofluoranthenes and dibenzanthracenes.

(A) No-burn samples from Home 2 consisted of 3, 24 hour samples due to power failure.

(B) No-burn samples from Home 5 consisted of 2, 24 hour samples due to equipment failure.

The minimum detectable concentration for fluoranthene, pyrene, benz(a)anthracene, benzofluoranthenes and benzo(a)pyrene was approximately .05 ng/m^3. The minimum detectable concentration for benzo(ghi)perylene and dibenzanthracenes was approximately .1 ng/m^3.

intrusion that homes 4 and 5. This is consistent with the air exchange rates listed in Table 2.

Further investigation into the nature of the indoor exposure concentrations in house #1 was conducted to determine the cause of the marked increase in aerosol mass and PNA concentrations during wood stove use; the cause was determined to be due to excessive fugitive emissions entering the room as a result of inadequate stove maintenance and/or design. Results are discussed below.

6.0 DISCUSSION OF RESULTS

Few studies of indoor exposure to residential wood smoke have been conducted to date, but some useful comparison can be made. Table 10 summarizes the results of several recent studies involving the use of wood stoves or fireplaces. Respirable suspended particulates ($<3.5\ \mu m$) were measured for varying periods of time. Two of the investigations simultaneously sampled outdoor ambient levels. In all the homes where outdoor measurements were made, the indoor concentrations were higher than the outdoor values.

Benton, et.al., measured the concentration of respirable aerosol ($<3.5\ \mu m$) in five rural Kansas homes using wood fuel. Condensible organic species were characterized by gas chromatography. Respirable particulate levels during the wood burning period were found to average 33 $\mu g/m^3$ for a 12-hour period and range upward to 66 $\mu g/m^3$.[5] These results indicate aerosol concentrations higher than those found during this study, possibly due to the quantity of wood burned, the nature of wood burning appliances used or experimental design. It is important to note that the length of the sampling period (in this study 24 hours) is likely to have a significant impact on the measured emissions due to the averaging effect of the sample time. For example, for a given day (24-hour period) during which a wood stove is used for 8 hours, one would reasonably expect an 8-hour air sample taken simultaneously with the 8 hours of stove operation to yield a higher emission level (ng/m^3) than a sample taken over the entire 24-hour period. Consequently, both the sampling procedure and the amount of appliance usage is likely to affect the results.

Spengler's studies of day-to-day variation in indoor air quality and its relationship to specific household activities emphasizes the importance of cooking, smoking and fireplace use. The following excerpt serves as an example:

Table 10

Indoor-Outdoor Respirable Particulate Concentrations

Study	Woodburner in Home[a]	No. of Days Sampled	Outdoor Concentration[b] (μg/m³)	Indoor Concentration[b] (μg/m³)
Spengler[6]	No	25	11.5(2.4-22.7)	15.2(8.4-23.0)
	No	30	10.9(2.4-18.3)	20.9(7.6-72.4)
	Yes(W)	30	12.5(4.8-24.0)	27.5(8.4-60.3)
	Yes(F)	30	10.3(3.7-21.6)	17.9(7.6-61.8)
Benton[5]	Yes (W)	2	ND[c]	24-66[d]
	Yes (F)	2	ND	34-40[d]
	Yes (W)	2	ND	33-37[d]
	Yes (W)	2	ND	37[d]
	Yes (W)	2	ND	12-20[d]
GEOMET[7,8]	Yes (W)	14	34.2(22.6-57.6)	49.0(14.3-72.5)
	No[e]	14	27.4(13.9-53.7)	28.0(23.9-31.6)
	Yes (F)	1	30.3	159.9
	No[e]	14	14.0(7.3-21.8	40.9(21.7-66.9)
	Yes (F)	1	6.0	67.6
	No[e]	14	17.9(7.7-30.5)	18.8(6.3-39.0)

[a] (W) - woodstove, (F) fireplace

[b] The concentration range is in parentheses.

[c] ND - not determined

[d] 12 hr. sampling time per day

[e] This is the same residence as the entry directly above, except the woodburner is not in operation.

> "Before turning to the analysis of the data, it is interesting to look at the data for the individual homes to see the effects of unusual occurrences against the background of normal daily patterns. For (home W1), December 24, 1979, was the day before Christmas and several of the occupants were away. The dining room was not used, no meals were cooked, and the second-floor bedroom was unoccupied. For this day, the uniformity of room concentrations is remarkable. The indoor concentrations ranged from 20.8 to 22.8 $\mu g/m^3$. The outdoor concentration was 22.7 $\mu g/m^3$ and the I/O (indoor/outdoor) ratio was 0.96.
>
> On the same day (December 24, 1979), for (home N) indoor respirable particle concentrations were much higher than normal. The home was occupied for 4.5 hours with 30 people enjoying a party. The higher levels reflect activities such as cooking, smoking, and use of the fireplace. The indoor concentrations ranged between 49 and 80 $\mu g/m^3$ while the outdoor level was 24.5 $\mu g/m^3$.
>
> For (home W2), December 2, 1979, stands out for its high values. On this day the house was occupied by about a dozen people, including several smokers, and a turkey was roasted for several hours. With an outdoor level of 15.7 $\mu g/m^3$, the indoor concentrations averaged 60 $\mu g/m^3$ and ranged between 59 and 63 $\mu g/m^3$. This home is heated in the winter almost exclusively by a wood stove in the dining room. However, on December 7, 1979, the wood stove was not used at all, and no smoking occurred in the house all day. Concentrations in all rooms were unusually low on this day. The outdoor concentration was 5.1 $\mu g/m^3$ and the indoor concentrations ranged from 6 to 11 $\mu g/m^3$."

In addition to the concentration of respirable suspended particulates, the composition of pollutants is of concern. For example, Moschandreas, et. al., measured indoor and outdoor benzo(a)pyrene (BaP), a by-product of wood and known carcinogen, at two of the residences.[7] At one residence on a woodburning day, the indoor BaP concentration was 11.4 ng/m^3 while the average indoor concentration during twelve day's with no woodburning activity was 0.6 ng/m^3. The outdoor levels were even lower.

Another study involved sampling indoor and outdoor air at twenty residences with woodburning facilities.[8] Ten residences had woodstoves and ten had fireplaces. Concentrations of total suspended particulates (TSP), carbon monoxide, benzo(a)pyrene (BaP), total aldehydes, and formaldehyde were determined on both a day when woodburning occurred and a day when it did not occur. Results indicate a correlation between elevated TSP, CO and B(a)P indoor concentrations for the woodburning days compared to non-woodburning days, while aldehvde and formaldehyde indoor concentrations could not be attributed strictly to woodburning.

The measured indoor particulate concentration generally increased during woodburning periods with respect to both the measured values during non-woodburning periods and measured ambient concentrations. A maximum B(a)P indoor concentration of 9.7 ng/m^3 was measured as compared to ambient and non-woodburning concentrations of less than 0.5 ng/m^3.

Comparison of indoor and outdoor PNA concentrations by Butler found that PNA levels are normally of the same magnitude.[10] Butler also suggests that if one assumes a normal breathing volume of 15 m^3 of air per day and that 90% of the B(a)P is associated with particles in the respiratory range, daily exposure to B(a)P can be calculated from the measured concentrations. Using this basis, the occupants of house 1 of this study exposed to average B(a)P concentrations of 26 ng/m^3 would breathe approximately 350 ng of B(a)P per day.

To place this information in perspective, it is useful to examine the level of personal exposure associated with cigarette smoking. The dosage of B(a)P associated with cigarette smoke ranges from 8-50 ng/cigarette. Wynder[11] suggests, as a typical case, that one cigarette will deliver about 34 ng of B(a)P to the body by way of cigarette smoke, assuming a retention time in the lungs of from 5 to 30 seconds. B(a)P exposure to residents of house 1, then, would be equivalent to about 10 cigarettes per day during the 5 day wood burning period. Similarly, data on B(a)P dosage of cigarette smoke from Bridbord, et. al., would suggest an exposure equivalent to 38 cigarettes/day.[12]

The B(a)P concentrations measured in his study can also be compared to measured ambient air concentrations in the Pacific Northwest. In the late 1970's, annual average concentrations of B(a)P ranged from 2.3 to 4.8 ng/m^3 in Portland, Eugene and Medford. The highest quarterly composite measured was 8.2 ng/m^3 in Medford during 1968. Current concentrations in Oregon are not known, but trends in the organic content of air samples indicate that B(a)P concentrations may be increasing.[13]

Other comparison of indoor PNA concentrations measured in houses 2-5 (0.2-0.3 ng/m^3) with annual average B(a)P concentrations in Pacific Northwest cities, suggests that indoor concentrations during the sampling period were significantly lower than the annual mean. The indoor sample concentrations, however, represent a 6 day average concentration during a period of relatively good ventilation, mild temperatures and low space heating demand. Consequently, direct comparison of the indoor concentrations with annual mean values is difficult. Butler, however, reported data for simultaneously measured indoor and outdoor PNA concentrations in Birmingham, U. K. Table 11 summarizes the results obtained by Butler, et. al.

Table 11

Comparison of Indoor and Outdoor
PNA Concentration in Birmingham, U. K.
(ng/m^3)

	Outside	Inside
TSP	47.5 ± 13.2	56.0 ± 41.3
Pyrene	2.62 ± 1.42	1.32 ± 1.41
Chrysene	4.56 ± 2.19	3.98 ± 3.31
B(a)P	2.88 ± 0.54	2.10 ± 1.88
B(e)P	2.19 ± 0.95	2.28 ± 2.16
Coronene	0.92 ± 0.38	0.43 ± 0.24

Butler's results indicated that indoor and outdoor concentrations were similar within the range of experimental uncertainty.

Investigation into the cause of the increase in aerosol mass and PNA concentration at house 1 indicated that visible smoke leakage from the charging door during appliance loading and operation was caused by partial blockage of the flue by wood ash and creosote. Other smoke leakage around the metal-to-metal fitting between the stove exit pipe and the sheet metal sealing the fireplace opening is also likely. The stove-front glass window of the appliance was covered with creosote, testifying to the smoke leakage. As a result, concentrations measured in home 1 are markedly higher than other homes included in the survey, exceeding typical ambient concentrations by a factor of ten.

7.0 PROGRAM CONCLUSIONS

The program results indicate that indoor exposure to occupants of wood burning households is likely to be highly dependent upon the operation, maintenance and design of the appliance used in the home. Concentrations of aerosol mass and PNA species within homes equipped with well maintained wood stoves that had no associated fugitive wood smoke emissions were not significantly different during periods of wood burning when compared to similar periods of no wood burning. These conclusions are, however, predicated on program results obtained during a period of very moderate weather conditions and associated space heating requirements. Had the field program taken place during a period of colder weather, the amount of wood burned per household would probably have increased by a factor of two or three. There is no direct evidence, however, to suggest that an increase in the rate of wood burned or frequency of wood stove use would result in a proportional increase in mass or PNA concentration. However, since the samples were obtained over a complete 24-hour period (as opposed to air samples coinciding only with the exact time of wood stove use), one would reasonably expect that as the period of wood stove usage increases the measured average emissions would also increase (e.g., 24-hour average emissions measured during a 24-hour period with 20 hours of wood stove use would be expected to be higher than a 24-hour average emission measured during a 24-hour period with only 4 hours of stove usage).

The most important finding of Task 7 was the high level of indoor PNA exposure associated with the use of wood burning appliances that leak smoke because of design deficiencies, poor maintenance, faulty installation, or improper operation. Recent surveys of Portland households indicate that about 5-15% of the urban area households used wood as a primary heat source and that about 50% of urban households burn wood as a secondary heat source or for aesthetic reasons.

As the popularity of wood as a space heating fuel increases, and wood burning appliances become older, the potential for public indoor exposure from leaky appliances will grow increasingly important. The potential risk to the public health will depend upon the number of appliances in use and the severity of emission leakage into the home. Since no information is available upon which to judge the likely extent of this problem within the 253,000 Portland households that burn wood, further assessment of the possible extent of public health risk cannot be addressed until additional information is available.

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Appendix A

Procedures:

Sampling and Analysis to Determine the Contribution of Residential Wood Combustion Emissions to Indoor Hazardous Particulate Pollutant Levels

I. Introduction

Indoor inhalable concentrations of particulate mass, polynuclear aromatic compounds (PNA) and lead will be measured in five homes. Outdoor inhalable lead concentration will also be measured at each of the five home sites. To calculate ambient concentration levels the following parameters must be determined: (1) the volume of air sampled, (2) the total mass of particulates collected, (3) the mass of lead collected and, (4) the mass of specific polynuclear aromatic compounds which were collected. A description of the quality assurance measures which will be taken in the determination of each of those four parameters is presented here. In addition, a section on (1) sample transport and processing and (2) data handling and reporting is also included.

II. Sample Transport and Processing

Preweighed 47 mm glass fiber filters (Pallflex Products Corp., Type 2500QAO, ref. No. 37970) will be placed into Nucleopore Aerosol Holders (stock No. 430400). Prior to positioning the filters into the aerosol holders, a Nucleopore drain disk (stock No. 231100) will be placed over the filter holding grid to insure uniform flow characteristics across the filter and to prevent the filrer from adhering to the "O" ring seal gasket of the holder. All filter processing (except weighing) will be performed in an Atmos-Tech Industries laminar flow hood. Each filter holder will be labeled with its corresponding filter number. Each filter holder will be wrapped in a plastic bag to prevent contamination and a plastic cap will be placed over them for mechanical protection. The filter holders will be placed in a specially constructed sample transport box which holds the filter holders upright and in numerical order. When the filter holders are removed from the sample transport boxes for use the plastic bag and cap are removed and placed in the sample transport boxes. The plastic bag and cap are put back on the filter holder after the 24 hour sample is collected and the filter holders containing the loaded filters are replaced in their original position in the sample transport box. The filters are never directly handled in the field. A "Tip-n-Tell" indicator (Specification Pkg., Corp.) will be placed on the sample transport boxes to provide a record if the sample transport boxes were inverted or mishandled. Five filters plus two blanks (in holders) will be placed in each sample transport box for each home study period. Log-in and log-out records will be maintained for the sample transport boxes. Upon receipt at NEA Laboratories, the loaded filters will be removed from their holders with forceps, weighted, placed in Nucleopore petri dish slides (stock No. PD 1504700) and stored upright in a freezer at -10°C for subsequent analysis.

III. Mass Determination

The weight of filters will be determined before and after sample collection with a Cahn 27 Automatic Electrobalance. Quality control is maintained by checking calibration and tare weight after every 20 filters are weighed. If weights are off by more than ± .040 mg the entire set is reweighed. Additionally after every set of 20 filters, 3 are chosen at random for reweighing. If their weights are not within ± 50 ug of the original value, the entire set of 20 must be reweighed. Filters will be handled only with forceps and will be placed into numbered Nucleopore petri dish slides after weighing. Filters will be transferred from the petri dish slides to the filter holders in the laminar flow hood. The numbered petri dishes will be retained for reuse with the same filter after samples have been collected and the loaded filters are weighed.

IV. Sample Volume Measurement

Each lo-vol sampler will be equipped with VDOOTA Vacuum gauge (liquid filled, 0-30 in. Hg pressure range) with a 2½% accuracy (manufacturer's specifications). One vacuum reading will be made when each 24 hour run is initiated, one at the end of the run when the filter is fully loaded and an intermediate measurement will also be taken. This procedure will be repeated for each filter. Before the lo-vol samplers are taken into the field and after the study is completed and the samplers are returned to NEA Laboratories' facilities, a flow rate versus pressure drop calibration curve will be constructed for each lo-vol sampler unit. An artificial pressure drop will be produced by putting an Alkon J valve in the position where the filter holder would normally attach. The flow rate through the system will be measured at various vacuum levels (as measured by the in line (VDOOTA vacuum gauge) with a Kurz Instruments Inc. Model 544 mass flow meter. The accuracy of the flow meter is 2% FS and its precision is 0.25% FS (manufacturer's specifications). A Gast vacuum pump model 0822-V103-G271X will be used in the lo-vol sampler. The pump pulls a maximum of 26 in. Hg vacuum (zero flow). Prior to installing the lo-vol sampler in the field the inlet will be plugged and a vacuum measurement will be made to insure that the pumps are fully operational and that there are no leaks in the system. Because an integrated volume must be calculated (the product of the mean flow rate and time) an upper limit of 15 minutes of uncertainty over a 24 hour period will be assigned (1.04%). A more accurate uncertainty value can not be estimated as each individual home resident will be responsible for recording the sampling periods and changing filter holders. It should be noted that the change in pressure drop between clean and fully loaded filters is expected to be small as will the corresponding change in flow rate. The change in flow rate will be assumed to be linear with time. The validity of this assumption and the uncertainty in the integrated volume values will be discussed in the final report after the study data is compiled and evaluated.

V. Lead Measurement - X-Ray Fluorescence Analysis

Much of the quality assurance of the x-ray fluorescence (XRF) analysis method is built into the XRF standard operating procedures manual. The filters are loaded and unloaded into specially machined acrylic holders for direct insertion into x-ray spectrometer. The filter holder loading is conducted in the laminar flow hood to prevent possible contamination. The filters themselves are handled with forceps at the edge of the filter, out of the deposit and analysis area.

To prevent confusion in identificacion of the samples during analysis uniform sample loading and ID number recording procedures will be followed. Sample ID numbers are recorded on a log sheet indicating analysis position. The samples are loaded into holders labeled with the appropriate analysis position. During unloading, the sample ID numbers and analysis position numbers are checked against the log sheet.

Calibration of the instrument is by thin film standards prepared by Micrommater, Inc., Seattle, WA., and by multielement solution deposited standards prepared by Columbia Scientific Industries, Austin, TX. The solution deposited standards are corrected for absorption effects.

Inter-laboratory comparison is an essential part of XRF analysis quality assurance. NEA recently participated in a comparison of polymer film standards prepared by Thomas Dzubay, EPA, Research Triangle Park, NC. Seven other laboratories participated in the comparison and analysis techniques other than energy dispersive XRF were used. These included instrumental neutron activation analysis, optical spectroscopy and wavelength dispersive x-ray fluorescence.

NEA currently is doing the quality assurance analysis of dichotomous sampler filters from the EPA's Inhalable Particulate Monitoring Network. Other recent inter-laboratory comparisons include one with the Oregon Graduate Center, Beaverton, OR., for analysis of air filters by XRF.

NEA routinely and frequently does inter-method comparisons with instrumental neutron activation analysis. This completely independent method provides inter-method comparison for about 20 elements.

For each XRF analysis batch of ten samples, a quality control standard is analyzed. Measured concentrations of the quality control standard, which contains several key elements, are compared with actual concentrations. If the deviation is more than ± 2%, all samples of that run must be reanalyzed. The results of the quality control standard over a number of runs provides a measure of the XRF analysis precision. If the results show a trend in drift, recalibration is required.

Finally, several elements, including K, Ca, Fe, As, Br and Pb are measured under more than one of the three excitation conditions normally used for each run. Results of these elements are compared for each of the excitation conditions under which they are measured. If agreement is not within the calculated uncertainties, the sample must be analyzed again.

VI. Neutron Activation Analysis

Phase I

Quality assurance for neutron activation analysis is achieved by running blind standards as part of the analysis program. These standards are National Bureau of Standards (NBS), United States Geological Survey (USGS) and International Atomic Energy Agency (IAEA) Standards, as well as liquid standards prepared by NEA Laboratories. Urban particulate matter - NBS Standard Reference Material (SRM) # 1648, IAEA Soils SRM and USGS BRC-1 SRM are the primary standard reference materials used by NEA Laboratories. It should also be noted that NBS, USGS and IAEA have a wide variety of standard reference materials which are used randomly but at a lower frequency than the above named primary standard reference materials as part of the NEA Laboratories quality assurance program. The blind standards have a two-fold function: (1) to serve a check on the calibration of the instrument and (2) to monitor instrument drift throughout the period in which samples are analyzed. These standards are run at a frequency of 1 in every 14 samples.

Phase II

Phase II consists of the intercomparison of neutron activation analysis and x-ray fluorescence analysis. Elements such as bromine and manganese which have low detection limits and a high degree of precision with both methods are used to assess the relative accuracy of the two techniques and as a check for determinate errors.

VII. Polynuclear Aromatic Hydrocarbon Measurement

The polynuclear aromatic hydrocarbon (PNA) content of composite samples will be determined by gas chromatography/mass spectroscopy. Composite samples composed of 4½ filters (½ filter will be dedicated for lead analysis) collected during each sampling period will be extracted and concentrated by standard procedures (e.g., Soxhlet extraction followed by separation and an alumina column and solvent removal). One blank and two blanks spiked with commercially available standard PNA compounds (available suppliers include RFR Corp. and Chem. Services) will be run with each group of ten samples. In addition surrogate standard compounds will be added to each sample, standard and blank. Anthracene-d_{10}, fluroanthracene and pyrene-d_{12} (available from PCR, Inc.) are several surrogate standard compounds which will be considered for usage.

Spectra validation tests, instrument detection limit tests and systems stability tests will be performed as outlined in: Performance Test for the Evaluation of Computerized GC/MS Equipment and Laboratories, U.S. EPA Environmental Monitoring and Support Laboratory, Office of Research and Development, 1980. Tests will include an instrument stability check and response to a standard compound such as decafluortriphenylphosphine.

VIII. Data Handling and Reporting

Routine audits will be performed on all data reduction and compilation procedures. All data will be entered into bound laboratory notebooks or standardized pre-printed data sheets with ink. Data terminology will be consistent with that developed by the American Chemical Society and the American Society for Quality Control Usuage.[1,2] A photocopy of raw data will be included as an appendix in the final report.

[1] "Guide for Measure of Precision and Accuracy", Anal. Chem., V.33, P.480, 1961

[2] "Glossary of General Terms Used in Quality Control," Quality Progress, Standard Group of the Standards Committee, ASQC, II (7), pp 21-2, 1969

A STUDY OF
RESIDENTIAL WOOD COMBUSTION

Task 7
Indoor Residential Sampling Program

Volume 2

Part 1: Study Introduction and Instructions

Part 2: Home Log Books

Part 3: Project Raw Gravimetric Data

BOOK NUMBER

1

RESIDENTIAL WOOD COMBUSTION
EMISSIONS TO
INDOOR HAZARDOUS POLLUTION

NEA LABORATORIES, INC.
8310 S.W. Nimbus Avenue
Beaverton, Oregon 97005
643-4661

After Hours
647-2109 D. Joseph
244-8534 J. Houck
646-9306 J. Cooper

SAMPLING AND ANALYSIS TO DETERMINE THE CONTRIBUTION OF RESIDENTIAL WOOD COMBUSTION EMISSIONS TO INDOOR HAZARDOUS PARTICULATE POLLUTANT LEVELS

Increased use of residential wood-burning appliances for space heating has created a concern for potential health hazards associated with exposure to wood combustion emissions both in the outdoor and indoor environments. Use trends and economic pressures indicate the use of these appliances is likely to increase. This coupled to increasing conservation efforts to reduce air exchange rates could lead to the build up of hazardous pollutant levels in the indoor environment.

Accute and chronic health effects are both possible. Short term accute health effects, exhibit obvious symptoms, however, and do not appear to be a major problem except in atypical situations. The main objective of this study is to assess the contribution of residential wood combustion emissions to indoor hazardous particulate pollutant concentrations associated with potential chronic health effects.

The proposed approach of this study is to measure the indoor concentration of selected hazardous and indicating chemicals associated with particulate emissions from residential wood combustion. The contribution of direct appliance emissions and resuspension of household dust to indoor concentrations will be evaluated with measurements made during maximum appliance use. The contribution from the infiltration of outside air will be assessed by two techniques: (1.) indoor measurements will be made during a period when the wood burning appliances are not in use, and (2.) lead, which is nearly unique to the outdoor environment, will be measured on samples simultaneously collected indoors and outdoors.

STUDY INSTRUCTIONS

FILTERS

EACH MORNING RECORD FILTER DATA AND CHANGE FILTER

- NOTE PRESSURE READING, TIME AND TEMPERATURE BEFORE REMOVING PREVIOUS DAYS FILTER
- INSTALL NEW FILTER
- NOTE FILTER NUMBER AND TIME
- 10 TO 30 MINUTES AFTER INSTALLING NEW FILTER NOTE NEW PRESSURE READING AND TEMPERATURE

AT SOME TIME DURING EVENING

- NOTE PRESSURE READING, TIME AND TEMPERATURE

WOOD STOVE OPERATION

- START FIRE WITH NEWSPAPER & SUPPLIED KINDLING ONLY
- USE ONLY FIREWOOD SUPPLIED

GENERAL

- DO NOT SMOKE IN HOUSE DURING TESTING PERIOD
- DO NOT BURN HOUSEHOLD TRASH IN WOOD STOVE
- NOTE ANY SIGNIFICANT AND/OR UNUSUAL EVENTS OCCURING IN AND AROUND HOUSE THAT MIGHT INFLUENCE AND/OR HELP IN THE ANALYSIS OF THE DATA

HOUSE INFORMATION SHEET

NAME: Peter B. Besserman

ADDRESS: [illegible] SE [illegible] Tree CT
Milwaukie, OR [illegible]

HOME PHONE: 654-8607

WORK PHONE: [illegible]-6279

FAMILY MEMBERS: Peter 47, Sally 45, Teresa 22, Suzanne 20, Claire 19, Gregory 17, Sharon 16, D[illegible] 14, [illegible] 10, Monica 7

HOUSE TYPE

STYLE: ranch

NUMBER OF ROOMS:

NUMBER OF FLOORS: 2

NUMBER OF BEDROOMS: 7

NUMBER OF SQ. FEET:

BASEMENT? No

WINDOWS - TYPE: storm windows 95%

INSULATION - HOW WELL:

VENT FANS: 3

WHERE: Kitchen over stove, one in each bathroom (three in all)

HOUSE AGE: Built 1948

HOUSE HISTORY: remodeled several times, into duplex in 1960's, garage added 1978

COOKING STOVE: GAS [✓ ELECTRIC]

HEATING SYSTEM OTHER THAN WOOD STOVE: all electric, remains in place

USE RELATIVE TO WOOD STOVE: used in kitchen constantly, used in bedrooms occasionally (once a month, i.e. someone sick)

NEIGHBORHOOD DESCRIPTION: single family homes on dead end street

GEOGRAPHIC DESCRIPTION: built up Clackamas County area known as Oak Grove or Oatfield Ridge, between Milwaukie and Gladstone

FREQUENCY OF HOUSE CLEANING: WEEKLY

TYPE OF VACUUM CLEANER: KERBY UPRIGHT

FREQUENCY OF COMPLETE HOUSE CLEANING: YEARLY

HOW CLEANED? SELF

LAST TIME CLEANED: MARCH

DUST RESUSPENSION POTENTIAL:
(Rank: 1 high - 5 low) 4

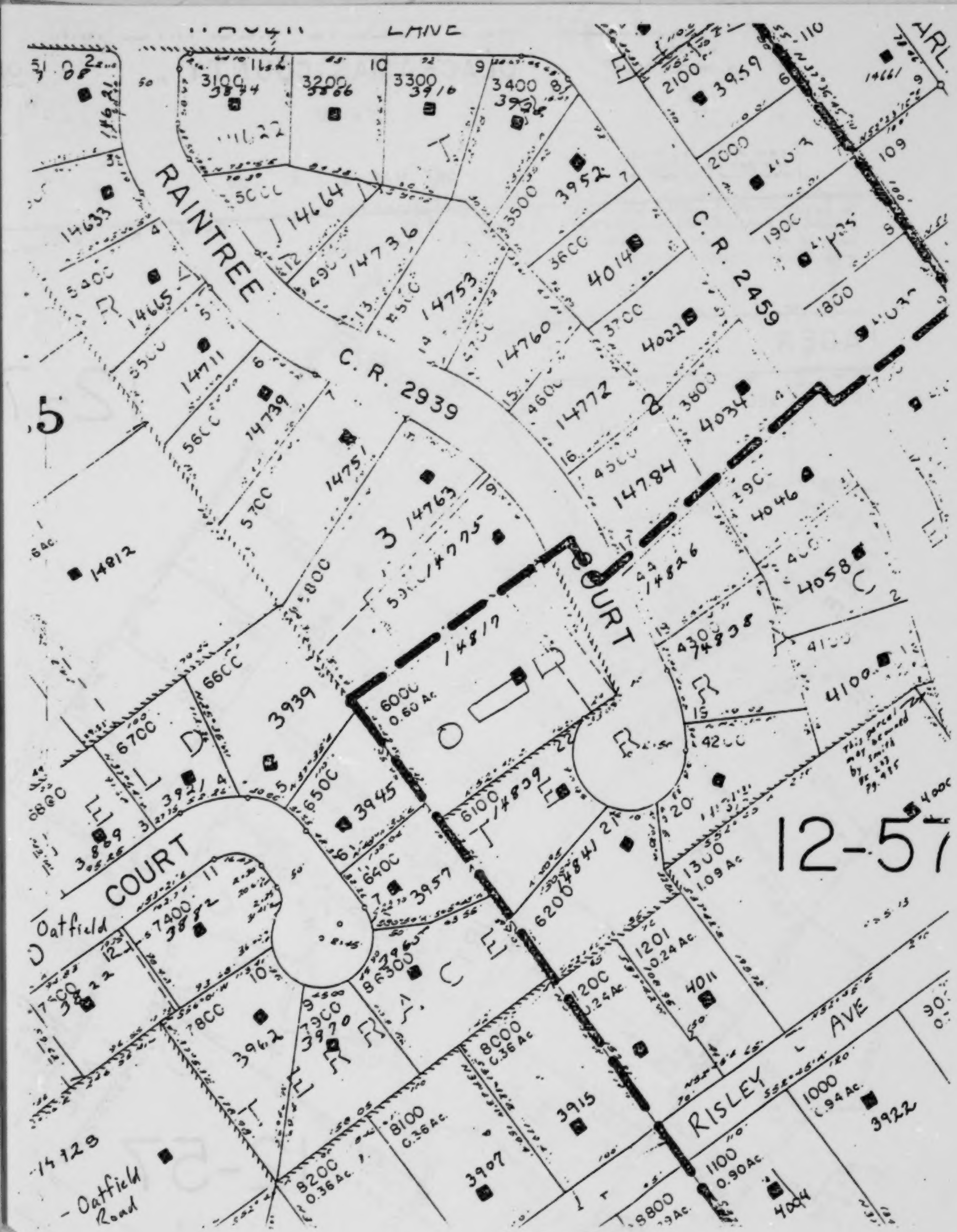
WOOD STOVE

TYPE: Odey

MODEL:

HISTORICAL USE IN HOUSE: 3rd season installed

USE RELATIVE TO GAS OR ELECTRIC HEAT: 90%


LANE
RAINTREE
C.R. 2939
C.R. 2459
COURT
COURT
RISLEY AVE
Oatfield
Oatfield Road
12-57
5
2
3
14622
14664
14736
14753
14760
14772
14784
14826
14838
14817
14763
14775
14751
14739
14711
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14621
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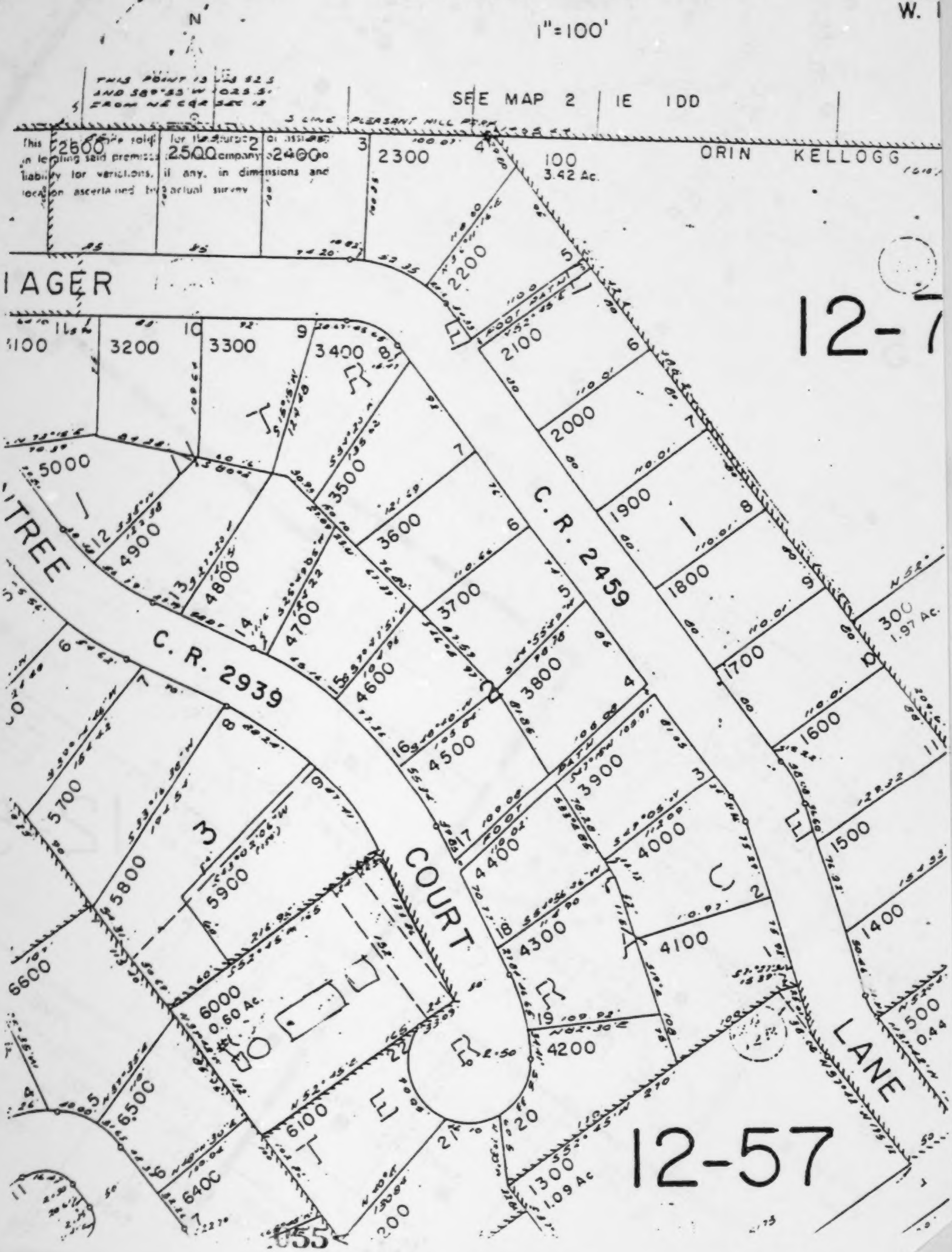
4058
4100
3939
3945
3957
3921
3869
3882
3822
3962
3970
3965
3915
3907
3922
4004
4011
6000 0.60 Ac.
1300 1.09 Ac.
1201 0.24 Ac.
1200 0.24 Ac.
8000 0.36 Ac.
8100 0.36 Ac.
8200 0.36 Ac.
1000 0.94 Ac.
1100 0.90 Ac.
This parcel may be owned by Smith

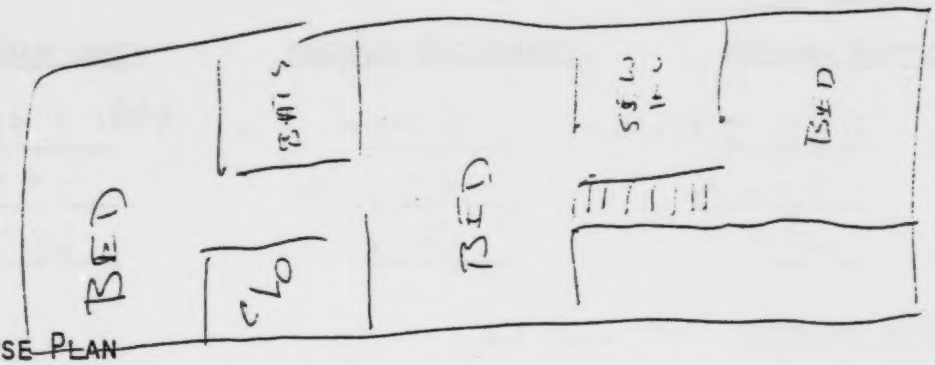
INSURANCE COMPANY
N STREET
Y, OREGON 97045

CLACKAMAS COUNTY ,

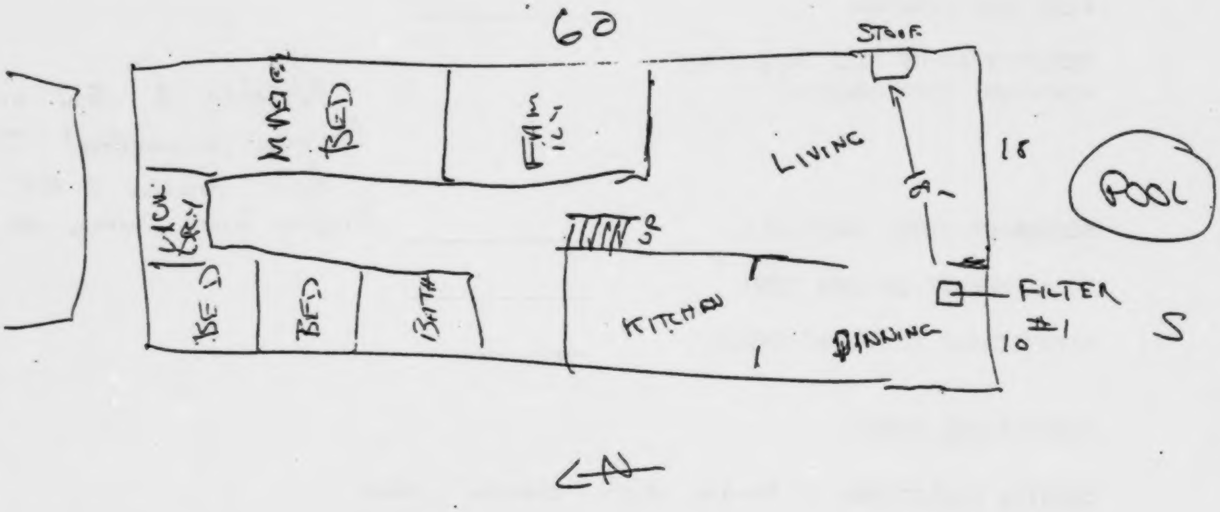
1"=100'


N
THIS POINT IS 52.5 AND S89°53'W 1025.5' FROM NE COR SEC 13
SEE MAP 2 1E 1DD
PLEASANT HILL PARK
This map is made solely for the purpose of assisting in locating said premises; the company assumes no liability for variations, if any, in dimensions and location ascertained by actual survey.
2600
2500
2400
2300
100
3.42 Ac.
ORIN KELLOGG
HAGER
2200
2100
2000
1900
1800
1700
1600
1500
1400
300
1.97 Ac.
500
0.44
12-7
3100
3200
3300
3400
3500
3600
3700
3800
3900
4000
4100
4200
4300
4400
4500
4600
4700
4800
4900
5000
5700
5800
5900
6000
0.60 Ac.
6100
6400
6500
6600
200
1300
1.09 Ac
TREE
C. R. 2939
C. R. 2459
COURT
LANE
FOOT PATH
12-57
055

SITE PLAN


BATH
SEW ING
BED
BED
CLO
BED

HOUSE PLAN


60
STOVE
MASTER BED
FAMILY
LIVING
18'
18
POOL
KID CRY
UP
BED
BED
BATH
KITCHN
DINNING
FILTER
#1
10
S
N

NOTE WOOD STOVE LOCATION

NOTE FILTER LOCATION

NOTE OTHER HEAT PRODUCING APPLIANCES

DAILY DATA SHEETS

DATE: May 8, 1981 Friday

FILTER INFORMATION

FILTER NUMBER: DL001

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/8/81 7:35 a.m.	5:30 p.m.	5/9/81 7:40 a.m.
PRESSURE:	-4.4 in Hg	-4.2 in Hg	-4.4 in Hg
TEMPERATURE:	66° F	69° F	62° F

WOOD STOVE OPERATION not used Today

TIME FIRE STARTED: __________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

Neighbor to SW using fireplace (or woodstove) 7:40 a.m.
Polish neighbor to NE using fireplace insert burning mill ends.

NUMBER OF TIMES REFUELED: __________

TOTAL NUMBER OF LOGS USED: __________

APPROXIMATE TIME FIRE ENDED: __________

WEATHER AND EVENTS

OUTSIDE CONDITIONS: 7:40 a.m. high overcast clouds

SIGNIFICANT AND UNUSUAL EVENTS:
neighbor child stayed overnight; houseguest of youngest child

DAILY DATA SHEETS

DATE: May 9, 1981 Saturday

FILTER INFORMATION

FILTER NUMBER: DL 0[illegible]02

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/9/81 7:40 a.m.	5:35 p.m. 5/9/81	8:25 a.m. 5/10/81
PRESSURE:	-5.2" Hg	-5.2	-5.3
TEMPERATURE:	62°F	72°F	60°F

WOOD STOVE OPERATION

TIME FIRE STARTED: not used today

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED:

TOTAL NUMBER OF LOGS USED:

APPROXIMATE TIME FIRE ENDED:

WEATHER AND EVENTS

OUTSIDE CONDITIONS: 8:30 a.m. Partly sunny, wind from NE, home on Hager Lane burning wood, smoke coming nearly at us

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: May 10, 1981 Sunday

FILTER INFORMATION

FILTER NUMBER: DL 003

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/10/81 8:25 a.m.	11:15 p.m.	7:20 a.m. 5/11/81
PRESSURE:	-5.4 in Hg	-5.5"	-5.6"
TEMPERATURE:	60° F	69°F	67°F

WOOD STOVE OPERATION

TIME FIRE STARTED: not used today

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ________

TOTAL NUMBER OF LOGS USED: ________

APPROXIMATE TIME FIRE ENDED: ________

WEATHER AND EVENTS

OUTSIDE CONDITIONS: Clear, sunny in morning
Cloudy in evening

SIGNIFICANT AND UNUSUAL EVENTS: 9:50 a.m. wind from north, 3866 Hager burning wood, heavy blue smoke; 14760 Raintree (Polish) has heat waves from fireplace insert

DAILY DATA SHEETS

DATE: May 11, '81 Monday

FILTER INFORMATION

FILTER NUMBER: DL004

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	7:41 a.m. 5/11/81		6:10 a.m. 5/12/81
PRESSURE:	-4.5"		-4.5
TEMPERATURE:	67°F		[illegible]°F

WOOD STOVE OPERATION

TIME FIRE STARTED: not used today

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ____

TOTAL NUMBER OF LOGS USED: ____

APPROXIMATE TIME FIRE ENDED: ____

WEATHER AND EVENTS

OUTSIDE CONDITIONS: 100% overcast

SIGNIFICANT AND UNUSUAL EVENTS: burned bottom of Tea Kettle 2:15 p.m.

Neighbor to north burning leaves and roto tilling; wind from the south 2:00 p.m.

.060<

DAILY DATA SHEETS

DATE: May 12 '81 Tuesday

FILTER INFORMATION

FILTER NUMBER: DL005

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	6:15 a.m. 5/12/81	5:00 p.m.	5:00 a.m. 5/13/81
PRESSURE:	-5.9"	-5.5"	-5.5"
TEMPERATURE:	61°F	70°F	65°F

WOOD STOVE OPERATION

TIME FIRE STARTED: no wood burned

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ____________

TOTAL NUMBER OF LOGS USED: ____________

APPROXIMATE TIME FIRE ENDED: ____________

WEATHER AND EVENTS

OUTSIDE CONDITIONS: clear & sunny

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: May 14, 1981 Thursday

FILTER INFORMATION

FILTER NUMBER: DL 041

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	6:42 a.m. 5/14/81	7:30 p.m.	6:38 a.m. 5/15/81
PRESSURE:	-4.7"	-5.0	-4.9"
TEMPERATURE:	64°F	68°F	61°F

WOOD STOVE OPERATION

TIME FIRE STARTED: 6:43 a.m. 5/14/81 by Grey

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder) started with bundle 34; split some of the logs for easier start

fire re-started at 7:00 p.m.

NUMBER OF TIMES REFUELED:

TOTAL NUMBER OF LOGS USED: 6 logs left; 3/4 of kindling

APPROXIMATE TIME FIRE ENDED:

WEATHER AND EVENTS

OUTSIDE CONDITIONS: overcast

SIGNIFICANT AND UNUSUAL EVENTS:

Vacuumed the carpeting in the living room, hall, bedrooms, stairs, etc.

DAILY DATA SHEETS

DATE: May 15, 1981 Friday

FILTER INFORMATION

FILTER NUMBER: DL042

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	6:43 a.m. 5/15/81	8:10 p.m.	7:53 5/16/81
PRESSURE:	-5.6"	-6.1"	-6.1"
TEMPERATURE:	61°F	67°F	62°F

WOOD STOVE OPERATION

TIME FIRE STARTED: 6:50 a.m. went out in afternoon

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder) restarted at 7:30 p.m.

NUMBER OF TIMES REFUELED: many

TOTAL NUMBER OF LOGS USED: finished first bundle started bundle 26

APPROXIMATE TIME FIRE ENDED:

WEATHER AND EVENTS

OUTSIDE CONDITIONS: 100% overcast
sunny in afternoon

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: May 16, 1981 Saturday

FILTER INFORMATION

FILTER NUMBER: DL 043

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	7:56 5/16/81	6:35 pm	7:56 a.m. 5/17/81
PRESSURE:	-5.4" Hg	-7.1	-7.4" Hg
TEMPERATURE:	64°F	70°F	62°F

WOOD STOVE OPERATION

TIME FIRE STARTED: 8:00 a.m.

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder) lots of kindling, hot fire out about 1 p.m. not restarted

NUMBER OF TIMES REFUELED:

TOTAL NUMBER OF LOGS USED:

APPROXIMATE TIME FIRE ENDED:

WEATHER AND EVENTS

OUTSIDE CONDITIONS: 8:00 a.m. 100% overcast
afternoon sunny

SIGNIFICANT AND UNUSUAL EVENTS:
grass mowed about noon Saturday

DAILY DATA SHEETS

DATE: May 17, 1981 Sunday

FILTER INFORMATION

FILTER NUMBER: DL·044

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	8:57 a.m. 5/17	4:10 p.m.	
PRESSURE:	-4.4" Hg	-7.4" Hg	
TEMPERATURE:	62°F	72°F	

WOOD STOVE OPERATION

TIME FIRE STARTED: 8:10 a.m.

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder) started with last four logs of 2d bundle and remainder of 1st kindling bundle split logs to make them burn easier

NUMBER OF TIMES REFUELED: ____________

TOTAL NUMBER OF LOGS USED: ____________

APPROXIMATE TIME FIRE ENDED: ____________

WEATHER AND EVENTS

OUTSIDE CONDITIONS: overcast, rainy in morning

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: May 18, 1981 Monday

FILTER INFORMATION

FILTER NUMBER: DL045

	INITIAL READINGS FINAL MAY 17	INTERMEDIATE READINGS 5/18	FINAL READINGS
TIME & DATE:	7:05 a.m.	3:10 pm.	
PRESSURE:	-7.7"Hg	-5.1"Hg	
TEMPERATURE:	65°F	73°F	

WOOD STOVE OPERATION

TIME FIRE STARTED: 7:05

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED:

TOTAL NUMBER OF LOGS USED:

APPROXIMATE TIME FIRE ENDED:

WEATHER AND EVENTS

OUTSIDE CONDITIONS: rainy

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: May 19, 1981 Tuesday

FILTER INFORMATION

FILTER NUMBER: DL045

	INITIAL READINGS FINAL MAY 18	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	7:02a.m.		
PRESSURE:	-5.25"Hg		
TEMPERATURE:	63° F		

WOOD STOVE OPERATION

TIME FIRE STARTED: ____________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ____________

TOTAL NUMBER OF LOGS USED: ____________

APPROXIMATE TIME FIRE ENDED: ____________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

BOOK NUMBER

2

RESIDENTIAL WOOD COMBUSTION
EMISSIONS TO
INDOOR HAZARDOUS POLLUTION

NEA LABORATORIES, INC.
8310 S.W. Nimbus Avenue
Beaverton, Oregon 97005
643-4661

After Hours
647-2109 D. Joseph
244-8534 J. Houck
646-9306 J. Cooper

HOUSE INFORMATION SHEET

NAME: [illegible] ADDRESS: [illegible]

HOME PHONE: [illegible] WORK PHONE: [illegible]

FAMILY MEMBERS: KATHY BARRY, GAIL KARL

HOUSE TYPE

STYLE: AIR TIGHT RANCH NUMBER OF ROOMS: 7

NUMBER OF FLOORS: 1 NUMBER OF BEDROOMS: 3

NUMBER OF SQ. FEET: 1200 BASEMENT? YES

WINDOWS - TYPE: STORM [illegible]

INSULATION - HOW WELL: R22 CEILING-BLOWN R11 WALL R19 FLOOR
WEATHER STRIPPING, INSULATE BASEMENT

VENT FANS: NONE - HEATING WHERE:

HOUSE AGE: ½ 40 YR ½ 10 YR

HOUSE HISTORY: LIVED IN HOUSE 3 YR

COOKING STOVE: GAS [✓ ELECTRIC]

HEATING SYSTEM OTHER THAN WOOD STOVE: ELECTRIC BASE BOARD

USE RELATIVE TO WOOD STOVE: REGULARLY IN 2 BED ROOMS ~3 [illegible] ½ ½ [illegible]

NEIGHBORHOOD DESCRIPTION: HOMES ON APPROX 1 ACRE LOTS

GEOGRAPHIC DESCRIPTION:

FREQUENCY OF HOUSE CLEANING: VACUUM WEEKLY SWEEP DAILY TYPE OF VACUUM CLEANER: OLDER KIRBY UPRIGHT

FREQUENCY OF COMPLETE HOUSE CLEANING: TWICE YEARLY HOW CLEANED? SELF

LAST TIME CLEANED: 6 MONTHS [illegible] DUST RESUSPENSION POTENTIAL: (Rank 1 high - 5 low) 3

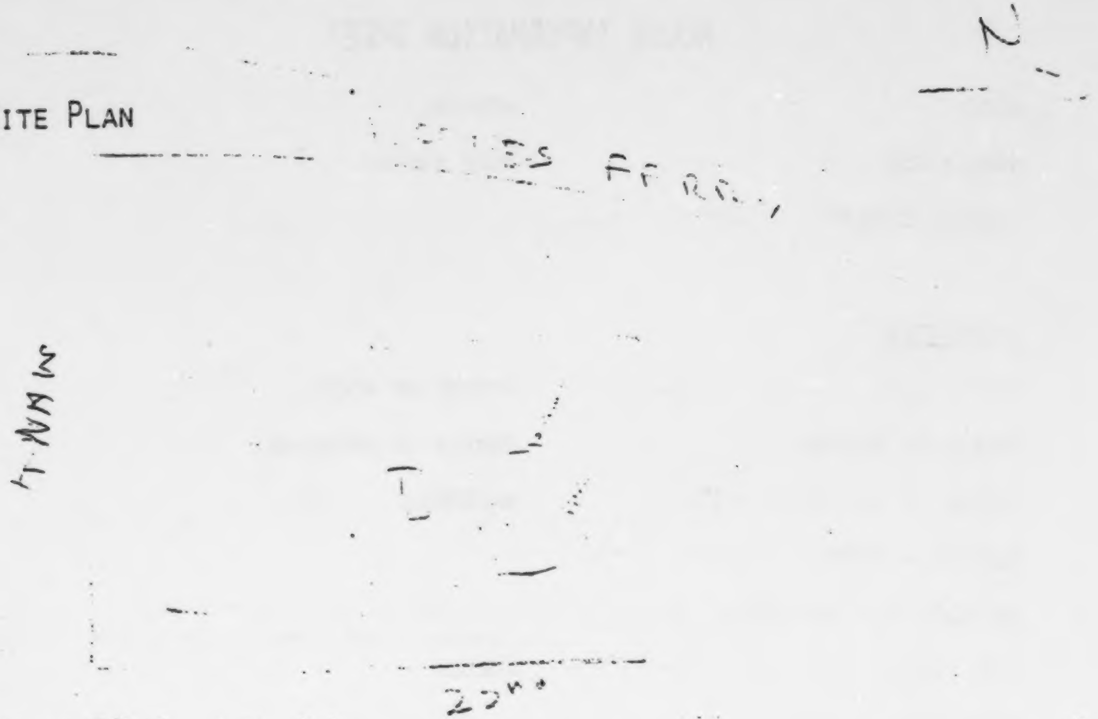
WOOD STOVE

TYPE: FISHER MODEL: MAMA

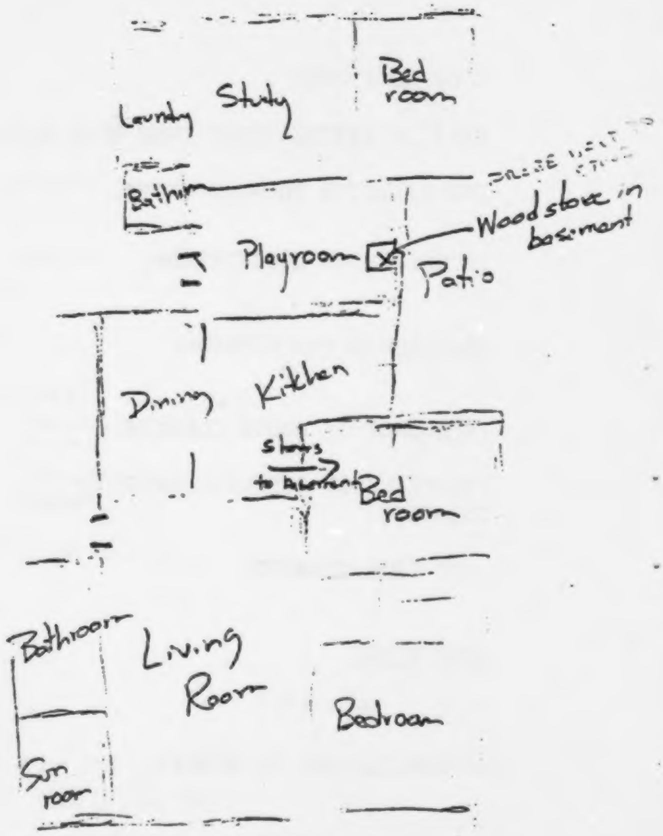
HISTORICAL USE IN HOUSE: IN USE 3 YRS
IF COLD OUT FIRE IN STOVE

USE RELATIVE TO GAS OR ELECTRIC HEAT: 2/3 - 3/4

SITE PLAN



HOUSE PLAN


Laundry
Study
Bed room
Bathrm
Playroom
Woodstove in basement
Patio
Dining
Kitchen
Stairs to basement
Bed room
Bathroom
Living Room
Bedroom
Sun room

NOTE WOOD STOVE LOCATION

NOTE FILTER LOCATION

NOTE OTHER HEAT PRODUCING APPLIANCES

DAILY DATA SHEETS

DATE: 5/8/81

FILTER INFORMATION

FILTER NUMBER: DL010

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/8 7:35 am	5/8 6:10 pm	5/9 9:30 am
PRESSURE:	-5.3	-5.0	-5.0
TEMPERATURE:	60° F	61°F	60° F

WOOD STOVE OPERATION

TIME FIRE STARTED: None

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ____________

TOTAL NUMBER OF LOGS USED: ____________

APPROXIMATE TIME FIRE ENDED: ____________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:
Partly Cloudy, 65° high

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: 5/9

FILTER INFORMATION

FILTER NUMBER: 11091

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/9 7:35 am	5/9 9:00 pm	5/10 9:20 am
PRESSURE:	-5.8	-5.5	-5.5
TEMPERATURE:	60°F	61°F	58°F

WOOD STOVE OPERATION

TIME FIRE STARTED: None

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: __________

TOTAL NUMBER OF LOGS USED: __________

APPROXIMATE TIME FIRE ENDED: __________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

Sunny, 65°F

SIGNIFICANT AND UNUSUAL EVENTS:

House spray painted on outside
Basement window open all night
Neighbors 1/2 block away burning brush

DAILY DATA SHEETS

DATE: 5/10/81

FILTER INFORMATION

FILTER NUMBER: DLC11

	INITIAL READINGS	* INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/10 3:30	5/10 10:20pm	5/11 7:35am
PRESSURE:	-4.5	-4.6	-4.6
TEMPERATURE:	59°	61°F	60°F

WOOD STOVE OPERATION

TIME FIRE STARTED: None

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ________

TOTAL NUMBER OF LOGS USED: ________

APPROXIMATE TIME FIRE ENDED: ________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:
Sunny, 65°F, windy

* SIGNIFICANT AND UNUSUAL EVENTS:
7:15pm Discovered basement power off! Don't know for how long — 6 hours? from 3 to 10pm?

DAILY DATA SHEETS

DATE: 5/11/81

FILTER INFORMATION

FILTER NUMBER: DL012

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/11 7:40am	5/11 9:10 am	5/12 10:30 am
PRESSURE:	-3.8	-3.75	-3.75
TEMPERATURE:	60°F	62°F	60°F

WOOD STOVE OPERATION

TIME FIRE STARTED: None

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ________

TOTAL NUMBER OF LOGS USED: ________

APPROXIMATE TIME FIRE ENDED: ________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

Sunny, breezy, 65°F

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: 5/12/81

FILTER INFORMATION

FILTER NUMBER: LL014

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/12 10:30	5/12 7:05	5/13 9:45
PRESSURE:	-3.75	-3.6	-3.75
TEMPERATURE:	60°F	63°F	62°F

WOOD STOVE OPERATION

TIME FIRE STARTED: ____________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ____________

TOTAL NUMBER OF LOGS USED: ____________

APPROXIMATE TIME FIRE ENDED: ____________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:
Sunny, 70°

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: 5/14/81

FILTER INFORMATION

FILTER NUMBER: 12055

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5:40 5/14	5/14 8:50	5/15 7:30
PRESSURE:	-4.1	-4.2	-4.2
TEMPERATURE:	62°	75°	67°

WOOD STOVE OPERATION

TIME FIRE STARTED: 5:30 pm

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

hot start-up, then slow fire, then hot fire - damped down, then smolder

NUMBER OF TIMES REFUELED: || 2

TOTAL NUMBER OF LOGS USED: |||| 3½

APPROXIMATE TIME FIRE ENDED: 2 am ?

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

Partly cloudy, occasional showers, 50's

SIGNIFICANT AND UNUSUAL EVENTS:

Power off for a few minutes

OUTSIDE

DAILY DATA SHEETS

DATE: 5/14/81

FILTER INFORMATION

FILTER NUMBER: DL056

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/14 9:45 am	5/14 9:15 pm	5/15 8:40 am
PRESSURE:	-5.8	-5.5	-5.4
TEMPERATURE:	57°	45°	44°

WOOD STOVE OPERATION

TIME FIRE STARTED: 3 pm

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ______

TOTAL NUMBER OF LOGS USED: ______

APPROXIMATE TIME FIRE ENDED: ______

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

Partly cloudy, occasional showers, 50°s

SIGNIFICANT AND UNUSUAL EVENTS:

Power off for a few minutes

DAILY DATA SHEETS

DATE: 5/15/81

FILTER INFORMATION

FILTER NUMBER: DL051

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/15 7:35am	5/15 6:00pm	5/16 8:45am
PRESSURE:	-3.8	-3.8	-3.9
TEMPERATURE:	67°	73° F	65°

WOOD STOVE OPERATION

TIME FIRE STARTED: 4:15pm

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

hot start-up, then hot fire but damped down

NUMBER OF TIMES REFUELED: /// 3

TOTAL NUMBER OF LOGS USED: /'// 3 1/3

APPROXIMATE TIME FIRE ENDED: 1 am

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

50°s, variable with rain & hail

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: 5/16

FILTER INFORMATION

FILTER NUMBER: DL050

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/16 8:45 am	5/16 7:40 pm	5/17 6:50 am
PRESSURE:	−4.6	−4.6	−4.6
TEMPERATURE:	65°	74°	65° F

WOOD STOVE OPERATION

TIME FIRE STARTED: 12:50 pm

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)
hot start-up, medium hot fire allowed to burn out

NUMBER OF TIMES REFUELED: II 2

TOTAL NUMBER OF LOGS USED: III 3

APPROXIMATE TIME FIRE ENDED: 9 pm

WEATHER AND EVENTS

OUTSIDE CONDITIONS:
50s, partly sunny

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: 5/17/81

FILTER INFORMATION

FILTER NUMBER: DL085

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	6:50 5/17	8:45 5/17	8:07 5/18
PRESSURE:	-4.1	-4.1	-4.1
TEMPERATURE:	66°	75°	70°

WOOD STOVE OPERATION

TIME FIRE STARTED: 4:30

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)
hot start up, medium fire

NUMBER OF TIMES REFUELED: || 2

TOTAL NUMBER OF LOGS USED: |||| 4

APPROXIMATE TIME FIRE ENDED: 1 am ?

WEATHER AND EVENTS

OUTSIDE CONDITIONS:
Cloudy, 50s, intermittent then steady rain

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: 5/18/81

FILTER INFORMATION

FILTER NUMBER: DL084

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	8:10 5/18	8:23 5/18	5/19 7:45
PRESSURE:	-5.4	-5.4	-5.4
TEMPERATURE:	70°	70°	66°F

WOOD STOVE OPERATION

TIME FIRE STARTED: 6 pm

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder) hot start-up, opps forgot about it - smoldering, then medium hot fire, then smolder

NUMBER OF TIMES REFUELED: 1 1

TOTAL NUMBER OF LOGS USED: 11 2

APPROXIMATE TIME FIRE ENDED: midnight ?

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

Rain, 50s

SIGNIFICANT AND UNUSUAL EVENTS:

BOOK NUMBER

3

RESIDENTIAL WOOD COMBUSTION
EMISSIONS TO
INDOOR HAZARDOUS POLLUTION

NEA LABORATORIES, INC.
8310 S.W. Nimbus Avenue
Beaverton, Oregon 97005
643-4661

After Hours

647-2109	D. Joseph
244-8534	J. Houck
646-9306	J. Cooper

HOUSE INFORMATION SHEET

NAME: KOWALCZYK
ADDRESS: 9941 S.W. 50th PTD

HOME PHONE: 244-1937
WORK PHONE:

FAMILY MEMBERS: [illegible]

HOUSE TYPE

STYLE: RANCH
NUMBER OF ROOMS: 7

NUMBER OF FLOORS: 1
NUMBER OF BEDROOMS: 3

NUMBER OF SQ. FEET: 1450
BASEMENT? NO

WINDOWS - TYPE: DOUBLE PANE 1/2" SPACE

INSULATION - HOW WELL: WELL SEE PGE DATA SHEET

VENT FANS: 2
WHERE: KITCHEN BATH

HOUSE AGE: 11

HOUSE HISTORY:

COOKING STOVE: GAS [✓ ELECTRIC]

HEATING SYSTEM OTHER THAN WOOD STOVE: ELECTRIC FURNACE

USE RELATIVE TO WOOD STOVE: AM ~~[illegible]~~

NEIGHBORHOOD DESCRIPTION: DEVELOPMENT - MAPLE GROVE HTS

GEOGRAPHIC DESCRIPTION: MT SEYUANYU

FREQUENCY OF HOUSE CLEANING: DAILY
TYPE OF VACUUM CLEANER: HOWER UP RIGHT

FREQUENCY OF COMPLETE HOUSE CLEANING: MONTHLY
HOW CLEANED? SELF

LAST TIME CLEANED: IN PROCESS
DUST RESUSPENSION POTENTIAL: (Rank: 1 high - 5 low) ~~[illegible]~~ 5

WOOD STOVE

TYPE: EARTH
MODEL:

HISTORICAL USE IN HOUSE: IN 4 yr. AGO - REGULAR USE

USE RELATIVE TO GAS OR ELECTRIC HEAT: MAJOR

Portland General Electric Company

WEATHERIZATION PROPOSAL

am [illegible] Phone 244-4937

ddress [illegible] S. W. 30th Division 2

ty Portland Zip Code 97219

pp ntment: Inspector 322 Date [illegible] Time 10:00am

ouse: Age 31 1/2 No. Stories (Incl. DB) 1 Basement/Crawl Area Heating System EFA

1 Ceiling Insulation: Type [illegible] Depth 4 in. Est. R= [illegible] Area Over Heated Space 1365 sq ft.

INSTALLATION COSTS/PAYBACK*

Recommendation: Add Insulation to Total Depth of ____ in. R= 30 Save [illegible] kWh/yr $ [illegible] /yr

Installation: Add ____ Bags of ____ Insulation (4 in. R= 13) Cost $ [illegible] / ____ yrs

2 Floor Insulation: Area Over Crawl Space 1365 sq ft. Has/Add Gr. Cover Cost $ ____ / ____ yrs

Recommendation: Add foil Insulation (R= 9) Save 2078.45 kWh/yr $ 51.97 /yr Cost $ [illegible] / ____ yrs

3 Wall Insulation: Total Area of Uninsulated Frame Wall ____ sq ft.

Options: Install Cell./UFC Insul. ____ sq ft. Save ____ kWh/yr $ ____ /yr Cost $ ____ / ____ yrs

(Insul. of existing walls is recommended if vapor barrier is installed on interior, warm side of the walls.)

4. Duct Insulation: No. Warm Air Registers ____ (Ducts in Unhtd. Area) ____ Ft. of Cold Air Return

Recommendation: Install ____ duct runs of R ____, ____ Ft. of R ____ Save ____ kWh/yr $ ____ /yr Cost $ ____ / ____ yrs

5 Pipe Insulation: Install ____ ft. of Hot Water Pipe Insulation Cost $ ____ / ____ yrs

6. Doors: No. Doors Into Htd. Space 3 No. Doors Not Insul. 3

Windows: Total Glass Area ____ sq ft. Single Glass Area 185.37 sq ft.

Recommendation: Install 2 Storm Door(s) Save 1275 kWh/yr $ 31.52 /yr Cost $ 315.00 / ____ yrs

Install 185.37 sq ft. { ~~St. Wind. or~~ Dbl. Glass } Save 2028.63 kWh/yr $ 50.50 /yr Cost $ 3229.91 / ____ yrs

Weatherstripping: ____ Linear ft. N/WS Save ____ kWh/yr $ ____ /yr Cost $ ____ / ____ yrs

8. Caulking: ____ Linear ft. of Uncaulked Crackage Save ____ kWh/yr $ ____ /yr Cost $ ____ / ____ yrs

Water Heater: Htd/UnHtd area. Temp Reset to 140° Save ____ kWh/yr $ ____ /yr Kit $ ____ / ____ yrs

10. Heating System Set Back Control: Save ____ kWh/yr $ ____ /yr Cost $ ____ / ____ yrs

11 Attic Ventilation: (Will Require Bid by Contractor) Cost $ ____ / ____ yrs

Total Installed Cost of Recommended Retrofit $ ____

*Calculated as principle plus interest at 6½%.

Estimated Total Potential Savings of Recommended Retrofit ____ Ann. kWh. $ ____ / ____ yrs

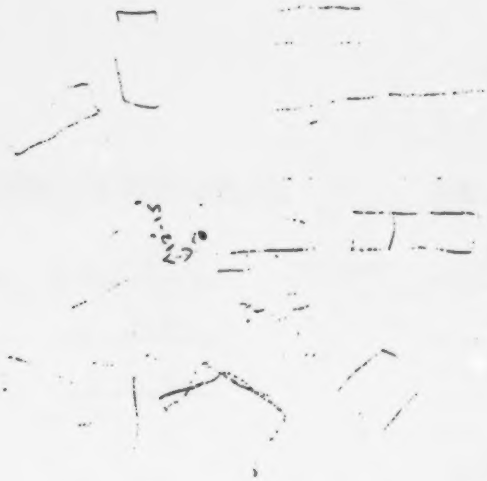
Estimates of Potential Savings Do Not Allow For Special Living Conditions or Family Habits — kWh Savings Are Not to be Construed as Guarantees by PGE. at $ 0.0 ____ kWr

Annual kWh: (prev. 12 mo.) Est. Domestic 9412 kWh. Est. Heating 4131 kWh. Total 13543 kWh.

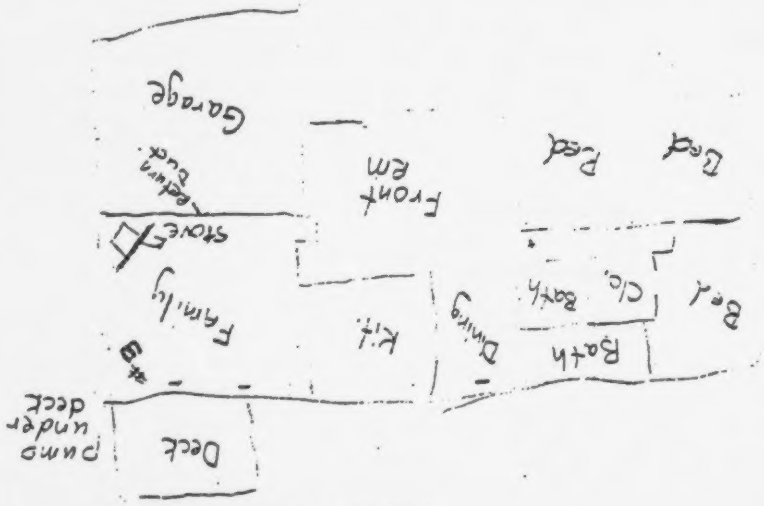
Inspected by ____ Date [illegible]

.084<

SITE PLAN



HOUSE PLAN


Garage
Return duct
Front Rm
Bed
Bed
Stove
Family
Kit.
Dining
Clo.
Bath
Bath
Bed
#3
Deck
pump under deck

NOTE WOOD STOVE LOCATION

NOTE FILTER LOCATION

NOTE OTHER HEAT PRODUCING APPLIANCES

DAILY DATA SHEETS

DATE: 5-8-81

FILTER INFORMATION

FILTER NUMBER: DL021

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	~~[illegible]~~ 7:00 am MAY 8	7:55 pm 5-8-81	5 49 5-9-81
PRESSURE:	5.	49	4.9
TEMPERATURE:	61	67	63

WOOD STOVE OPERATION

TIME FIRE STARTED: none

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ____

TOTAL NUMBER OF LOGS USED: ____

APPROXIMATE TIME FIRE ENDED: ____

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

Morning cloudy
Evening cloudy warm during the day

SIGNIFICANT AND UNUSUAL EVENTS:

Used Electric furn. in morning

DAILY DATA SHEETS

DATE: 5-9-81 - Saturday

FILTER INFORMATION

FILTER NUMBER: DLC-27

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	8:50 5-9-81	5:30 pm.	7:30 a.m.
PRESSURE:	35	35	35
TEMPERATURE:	63	65	63

WOOD STOVE OPERATION

TIME FIRE STARTED: None

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ______

TOTAL NUMBER OF LOGS USED: ______

APPROXIMATE TIME FIRE ENDED: ______

WEATHER AND EVENTS

OUTSIDE CONDITIONS: Morning - sunny

SIGNIFICANT AND UNUSUAL EVENTS:
outside alot

DAILY DATA SHEETS

DATE: 5-10-81 – Sunday

FILTER INFORMATION

FILTER NUMBER: DL023

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	9:30 Am 5-10-81	7.43 pm	7.32 am [illegible]
PRESSURE:	45	46	46
TEMPERATURE:	60	64	66

WOOD STOVE OPERATION

TIME FIRE STARTED: None

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ________

TOTAL NUMBER OF LOGS USED: ________

APPROXIMATE TIME FIRE ENDED: ________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

Sunny

SIGNIFICANT AND UNUSUAL EVENTS:

Outside alot

DAILY DATA SHEETS

DATE: 5-11-81

FILTER INFORMATION

FILTER NUMBER: DLC.24

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	7:15 am 5-11-81	7:05 pm	7:02 AM 5-12-
PRESSURE:	3.9	4.0	3.9
TEMPERATURE:	60	65	59

WOOD STOVE OPERATION

TIME FIRE STARTED: None

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ______

TOTAL NUMBER OF LOGS USED: ______

APPROXIMATE TIME FIRE ENDED: ______

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

Sunny

SIGNIFICANT AND UNUSUAL EVENTS:

had windows + doors open - cut grass front + back yard.

DAILY DATA SHEETS

DATE: 5-12-81

FILTER INFORMATION

FILTER NUMBER: D1020

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS 5-13-81	Cut-off
TIME & DATE:	7:15 am	7:02 pm	7:05	7:06
PRESSURE:	3.8	3.9	3.8	6 x
TEMPERATURE:	59	71	57	57

(cloudy)

WOOD STOVE OPERATION

TIME FIRE STARTED: None

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ____________

TOTAL NUMBER OF LOGS USED: ____________

APPROXIMATE TIME FIRE ENDED: ____________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

Sunny

SIGNIFICANT AND UNUSUAL EVENTS:

finished cutting grass

DAILY DATA SHEETS

DATE: 5-14-81

FILTER INFORMATION

FILTER NUMBER: DL057

			5-15-81
	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	7:15 Am	8:45 pm	7:00 am
PRESSURE:	7.1	6.9	7.0
TEMPERATURE:	66	76	64

WOOD STOVE OPERATION

TIME FIRE STARTED: 4:00 p.m.

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder) hot start-up - then smolder

NUMBER OF TIMES REFUELED: 0

TOTAL NUMBER OF LOGS USED: 2

APPROXIMATE TIME FIRE ENDED: 8:00 p.m.

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

rain

SIGNIFICANT AND UNUSUAL EVENTS:

None

DAILY DATA SHEETS

DATE: 5-15-81

FILTER INFORMATION

FILTER NUMBER: DL058

5-16-81

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	7:15 am	8:00 pm	7:43 Am
PRESSURE:	4.0	3.9	4.1
TEMPERATURE:	64	64	63

WOOD STOVE OPERATION

TIME FIRE STARTED: 8:30 pm

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

hot start - then smolder

NUMBER OF TIMES REFUELED: 0

TOTAL NUMBER OF LOGS USED: 1½

APPROXIMATE TIME FIRE ENDED: 9:50

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

sunny - rainy

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: 5-16-81

FILTER INFORMATION

FILTER NUMBER: DL 059

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	7:30 5-16-81	9:05 pm	9:20 am 5-17-81
PRESSURE:	4.8	4.8	4.8
TEMPERATURE:	63	72	64

WOOD STOVE OPERATION

TIME FIRE STARTED: 10:00 AM

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

hot start-up & burn

NUMBER OF TIMES REFUELED: 0

TOTAL NUMBER OF LOGS USED: 3

APPROXIMATE TIME FIRE ENDED: 1:30 pm

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

cloudy-sunny

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: 5-17-81

FILTER INFORMATION

FILTER NUMBER: DL060

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS 5-18-81
TIME & DATE:	9:40	8:50 pm	7:00 am
PRESSURE:	3.9	3.8	3.8
TEMPERATURE:	64	72	66

WOOD STOVE OPERATION

TIME FIRE STARTED: 10:10 Am

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

hot-start
hot 30min burn - then smolder

NUMBER OF TIMES REFUELED: 0

TOTAL NUMBER OF LOGS USED: 3

APPROXIMATE TIME FIRE ENDED: 2:30 pm

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

rain

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: 5-18-81

FILTER INFORMATION

FILTER NUMBER: DL061

	INITIAL READINGS	INTERMEDIATE READINGS	5-19-81 FINAL READINGS
TIME & DATE:	7:30	7:45	7:00 pm
PRESSURE:	5.0	5.2	5.2
TEMPERATURE:	66	80	65

WOOD STOVE OPERATION

TIME FIRE STARTED: 4:00 pm

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

hot start up-burn - then smolder

NUMBER OF TIMES REFUELED: 0

TOTAL NUMBER OF LOGS USED: 2

APPROXIMATE TIME FIRE ENDED: 7:30

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

Rain

SIGNIFICANT AND UNUSUAL EVENTS:

BOOK NUMBER

4

RESIDENTIAL WOOD COMBUSTION
EMISSIONS TO
INDOOR HAZARDOUS POLLUTION

NEA LABORATORIES, INC.
8310 S.W. Nimbus Avenue
Beaverton, Oregon 97005
643-4661

After Hours
647-2109 D. Joseph
244-8534 J. Houck
646-9306 J. Cooper

HOUSE INFORMATION SHEET

NAME: BABCOCK ADDRESS: 306 S.W. VALLEY FORGE

HOME PHONE: 645-8439 WORK PHONE: 627-3428

FAMILY MEMBERS: NORM, YVONNE, MISTY (6)

HOUSE TYPE

STYLE: MOBILE HOME NUMBER OF ROOMS: 3

NUMBER OF FLOORS: 1 NUMBER OF BEDROOMS: 2

NUMBER OF SQ. FEET: 950 BASEMENT? NO

WINDOWS - TYPE: STORM

INSULATION - HOW WELL: R19 CEILING/FLOOR R11 WALLS

VENT FANS: 2 WHERE: KITCHEN, BATH

HOUSE AGE: 5 yr.

HOUSE HISTORY: ORIGINAL LOCATION

COOKING STOVE: GAS [✓ ELECTRIC]

HEATING SYSTEM OTHER THAN WOOD STOVE: ELECTRIC FURNACE (FORCED AIR

USE RELATIVE TO WOOD STOVE: 1/3 $70 MID MARCH TO MID APRIL (~$50)

NEIGHBORHOOD DESCRIPTION: MOBILE HOME PARK

GEOGRAPHIC DESCRIPTION: TV

FREQUENCY OF HOUSE CLEANING: WEEKLY TYPE OF VACUUM CLEANER: KERBY UPRIGHT

FREQUENCY OF COMPLETE HOUSE CLEANING: TWICE YEARLY HOW CLEANED? SELF

LAST TIME CLEANED: LAST FALL DUST RESUSPENSION POTENTIAL: (Rank: 1 high - 5 low) 3

WOOD STOVE

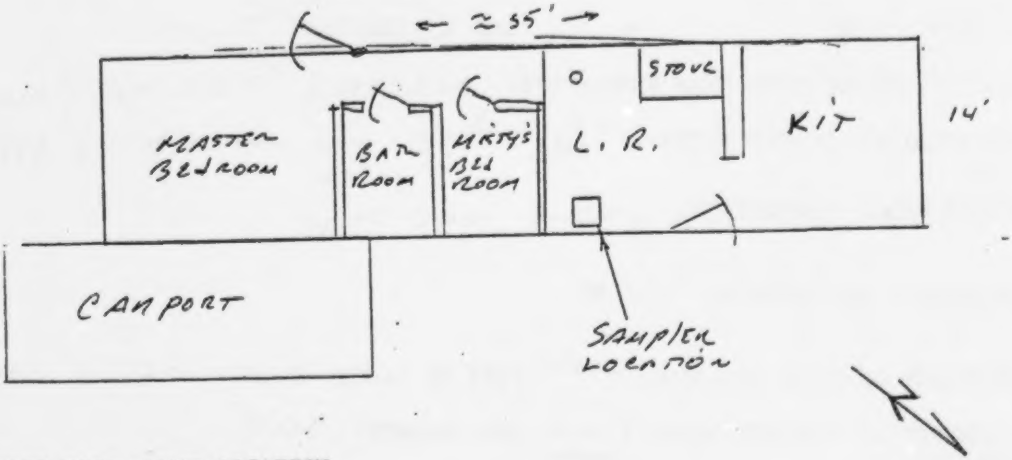
TYPE: ARROW MODEL: 1800

HISTORICAL USE IN HOUSE: INSTALLED JAN 1981

USE RELATIVE TO GAS OR ELECTRIC HEAT: 2/3 USE.

SITE PLAN

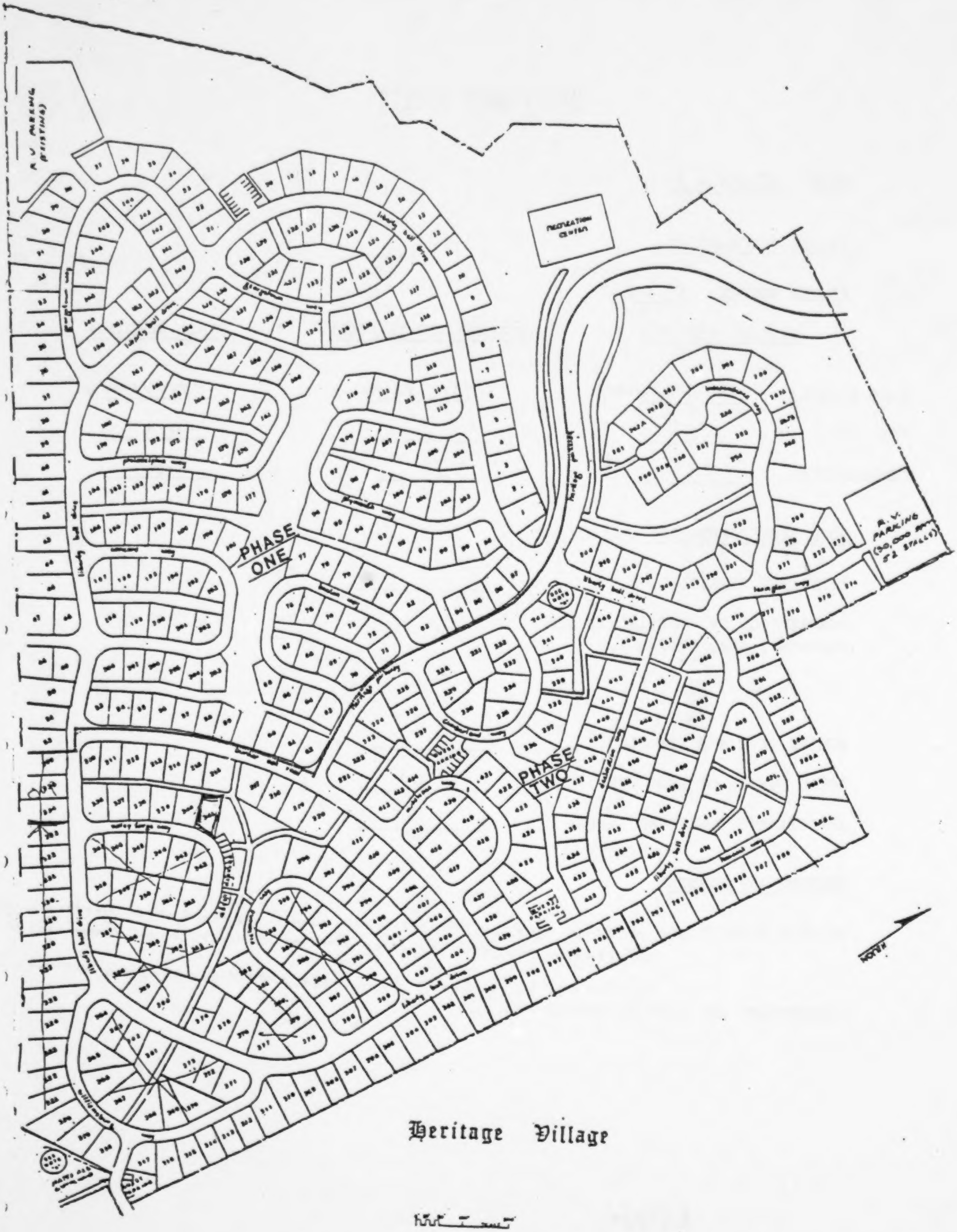
HOUSE PLAN


← ≈ 55' →
STOVE
MASTER BEDROOM
BATH ROOM
MISTY'S BED ROOM
L. R.
KIT
14'
CARPORT
SAMPLER LOCATION
N

NOTE WOOD STOVE LOCATION

NOTE FILTER LOCATION

NOTE OTHER HEAT PRODUCING APPLIANCES


R.V. PARKING
(EXISTING)
RECREATION CENTER
PHASE ONE
PHASE TWO
R.V. PARKING
(30,000 SQ.FT.
52 STALLS)
NORTH

Heritage Village

DAILY DATA SHEETS

DATE: 8 MAY 81

FILTER INFORMATION

FILTER NUMBER: DL025

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	0750/8 MAY	1950/8 MAY	0850/9 MAY
PRESSURE:	-3.9"	-3.9"	-4.0"
TEMPERATURE:	72°	73°	68°

WOOD STOVE OPERATION

TIME FIRE STARTED: ____________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ____________

TOTAL NUMBER OF LOGS USED: ____________

APPROXIMATE TIME FIRE ENDED: ____________

WEATHER AND EVENTS

OUTSIDE CONDITIONS: MORNING: HAZY OVERCAST, NO wind. SEVERAL AREA STOVES going.
AFTERNOON: OVERCAST w/ SOME broken PERIODS, wind from SOUTH,
building until 1700.
EVENING: OVERCAST, COOL, AREA STOVES burning. wind from
SIGNIFICANT AND UNUSUAL EVENTS: SOUTH.

DAILY DATA SHEETS

DATE: 9 MAY 81

FILTER INFORMATION

FILTER NUMBER: DL026

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	0855/9MAY	1958/9MAY	0853/10MAY
PRESSURE:	-4.4"	-4.4"	-4.5"
TEMPERATURE:	68°	72°	70°

WOOD STOVE OPERATION

TIME FIRE STARTED: ____________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ____________

TOTAL NUMBER OF LOGS USED: ____________

APPROXIMATE TIME FIRE ENDED: ____________

WEATHER AND EVENTS

OUTSIDE CONDITIONS: MORNING: BROKEN cloud cover, wind swinging TO WEST AND VARIABLE. TRASH fires IN AREA.

SIGNIFICANT AND UNUSUAL EVENTS: AFTERNOON; cloud cover primarily SCATTERED, outside 62° dropping to 55°, FRESH wind from WEST. Electric oven used for cooking.

EVENING: high SCATTERED clouds, wind from WEST.

Early A.M. of 10 MAY: BREAKFAST cooking filled kitchen + living room with smoke.

DAILY DATA SHEETS

DATE: 10MAY81

FILTER INFORMATION

FILTER NUMBER: DL027

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	0900/10MAY	2115/10MAY	0750/11MAY
PRESSURE:	-5.6"	-5.7"	-5.7"
TEMPERATURE:	70°	72°	72°

WOOD STOVE OPERATION

TIME FIRE STARTED: ____________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ____________

TOTAL NUMBER OF LOGS USED: ____________

APPROXIMATE TIME FIRE ENDED: ____________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

MORNING: BROKEN cloud COVER, SEVERAL STOVES IN AREA IN USE.

AFTERNOON: BROKEN changing TO SCATTERED. wind from WEST - WARM.

EVENING: clear - cold - windy (from WEST).

DAILY DATA SHEETS

DATE: 11MAY81

FILTER INFORMATION

FILTER NUMBER: DL028

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	0800/11MAY	2015/11MAY	0755/12MAY
PRESSURE:	-4.5"	-4.5"	-4.6"
TEMPERATURE:	70°	72°	74°

WOOD STOVE OPERATION

TIME FIRE STARTED: ________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ________

TOTAL NUMBER OF LOGS USED: ________

APPROXIMATE TIME FIRE ENDED: ________

WEATHER AND EVENTS

OUTSIDE CONDITIONS: MORNING: Broken to scattered cloud cover, wind from west.

SIGNIFICANT AND UNUSUAL EVENTS: AFTERNOON: scattered clouds, light wind from west. No apparent burning activity.

EVENING: clear, no wind, some wood burning activity.

DAILY DATA SHEETS

DATE: 12 MAY 81

FILTER INFORMATION

FILTER NUMBER: DL029

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	0800/12 MAY	2030/12 MAY	0758/13 MAY
PRESSURE:	-3.5"	-3.6"	-3.6"
TEMPERATURE:	74°	80°	70°

WOOD STOVE OPERATION

TIME FIRE STARTED: ____________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ____________

TOTAL NUMBER OF LOGS USED: ____________

APPROXIMATE TIME FIRE ENDED: ____________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

Morning: some cloud, no wind
Afternoon: clear + warm, very lt. breeze
Evening: hazy high cloud, no wind, warm (60° outside)

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: 14 MAY 81

FILTER INFORMATION

FILTER NUMBER: DL065

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	1745/14 MAY	0800/15 MAY	15 2039/16 MAY
PRESSURE:	-3.8"	-3.8"	-3.8"
TEMPERATURE:	71°	71°	70°

WOOD STOVE OPERATION

TIME FIRE STARTED: 1900

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder) PAPER, kindling, several small pieces from Bundle #2, HOT TO START. STOVE door OPEN for 1st 2-3 mins.

NUMBER OF TIMES REFUELED: 3

TOTAL NUMBER OF LOGS USED: 1/4 of Bundle #2

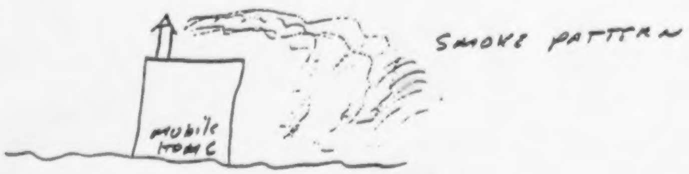
APPROXIMATE TIME FIRE ENDED: 0200/15 May (EST)

WEATHER AND EVENTS

OUTSIDE CONDITIONS: Evening: SCATTERED TO BROKEN clouds, some (Light) RAIN, FRESH BREEZE from WEST

SIGNIFICANT AND UNUSUAL EVENTS: MORNING: OVERCAST, no wind
Afternoon: OVERCAST with showers

AT START of fire:



DAILY DATA SHEETS

DATE: 16 MAY 81

FILTER INFORMATION

FILTER NUMBER: DL066

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	2040/16 MAY	0830/17 MAY	2030/17 MAY
PRESSURE:	-4.3"	-4.4"	-4.5"
TEMPERATURE:	70°	72°	73°

WOOD STOVE OPERATION

TIME FIRE STARTED: 2049

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder) Hot to start, open damper coals for rest of evening

NUMBER OF TIMES REFUELED: 2

TOTAL NUMBER OF LOGS USED: 1/4 of bundle #2

APPROXIMATE TIME FIRE ENDED: ≈ 2400

WEATHER AND EVENTS

OUTSIDE CONDITIONS:
Evening: clear, light breeze from west
Morning: overcast, no wind
Afternoon: scattered to broken cloud, light breeze from the east.

SIGNIFICANT AND UNUSUAL EVENTS:

2100 - smoke in room while refueling

DAILY DATA SHEETS

6

DATE: 17 MAY 81

FILTER INFORMATION

FILTER NUMBER: DL067

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	2030		
PRESSURE:	-4.7"		
TEMPERATURE:	73°		

WOOD STOVE OPERATION

TIME FIRE STARTED: ______

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ______

TOTAL NUMBER OF LOGS USED: ______

APPROXIMATE TIME FIRE ENDED: ______

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

TEST ABORTED - TOO WARM -

DAILY DATA SHEETS

DATE: 17 MAY 81

FILTER INFORMATION

FILTER NUMBER: DL068

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	2000/17MAY	0750/18MAY	1950/18MAY
PRESSURE:	-5.8"	-5.8"	-5.8"
TEMPERATURE:	74°	70°	72°

WOOD STOVE OPERATION

TIME FIRE STARTED: 2018/17MAY

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder) HOT START- DAMPER OPEN

NUMBER OF TIMES REFUELED: 3

TOTAL NUMBER OF LOGS USED: 1/4 of bundle #2

APPROXIMATE TIME FIRE ENDED: ≈ 2400

WEATHER AND EVENTS

OUTSIDE CONDITIONS: EVENING: OVERCAST WITH RAIN
NO WIND.
MORNING: OVERCAST- PERIODIC RAIN " VERY light
AFTERNOON: " "
wind from WEST.

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: 18 MAY 81

FILTER INFORMATION

FILTER NUMBER: DL069

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	2000/18 MAY	0800/19 MAY	2000/19 MAY
PRESSURE:	- 3.5"	-3.5"	-3.6"
TEMPERATURE:	72°	70°	76°

WOOD STOVE OPERATION

TIME FIRE STARTED: 2015

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder) HOT START - OPEN DAMPER for 20 min

NUMBER OF TIMES REFUELED: 2

TOTAL NUMBER OF LOGS USED: ≈ 1/4 of bundle #2

APPROXIMATE TIME FIRE ENDED: ≈ 2400

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

Evening: overcast - very light breeze
from south

2200: rain stopped, wind now from north.
Number of stove fires in area,
smoke not blowing away, stratified,
and creating visible haze.

Morning: overcast, rain

Afternoon: " "

DAILY DATA SHEETS

DATE: 19MAY81

FILTER INFORMATION

FILTER NUMBER: DL070

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	2010/19MAY	0800/20MAY	2000/20MAY
PRESSURE:	-4.5"	-4.5"	-4.6"
TEMPERATURE:	76°	70°	70°

WOOD STOVE OPERATION

TIME FIRE STARTED: 1900/15MAY

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder) hot start, open damper for 20 min then smolder

NUMBER OF TIMES REFUELED: 2

TOTAL NUMBER OF LOGS USED: remainder of bundle #2

APPROXIMATE TIME FIRE ENDED: ≈ 0300

WEATHER AND EVENTS

OUTSIDE CONDITIONS: Evening: overcast with some late clearing. no wind.
Morning: overcast, no wind.

SIGNIFICANT AND UNUSUAL EVENTS:

BOOK NUMBER

5

RESIDENTIAL WOOD COMBUSTION
EMISSIONS TO
INDOOR HAZARDOUS POLLUTION

NEA LABORATORIES, INC.
8310 S.W. Nimbus Avenue
Beaverton, Oregon 97005
643-4661

After Hours
647-2109 D. Joseph
244-8534 J. Houck
646-9306 J. Cooper

HOUSE INFORMATION SHEET

NAME: JOSEPH

ADDRESS: RT1 BOX 274C CORNELIUS
OR 97113

HOME PHONE: 647-2109

WORK PHONE: 645-1121

FAMILY MEMBERS: DARRELL, PHIL, SHEILA

HOUSE TYPE

STYLE: RURAL / LOW INCOME

NUMBER OF ROOMS: 4

NUMBER OF FLOORS: 1

NUMBER OF BEDROOMS: 2

NUMBER OF SQ. FEET: 600

BASEMENT? NO

WINDOWS - TYPE: SINGLE PANE, PLASTIC

INSULATION - HOW WELL: GOOD

VENT FANS: NONE

WHERE:

HOUSE AGE: 50

HOUSE HISTORY: OLDER HOME RECENTLY REMOLDED INSIDE
PREVIOUSLY WOOD COOK STOVE.

COOKING STOVE: GAS [✓ ELECTRIC]

HEATING SYSTEM OTHER THAN WOOD STOVE: ELECTRIC WALL UNITS

USE RELATIVE TO WOOD STOVE: NONE

NEIGHBORHOOD DESCRIPTION: RURAL

GEOGRAPHIC DESCRIPTION: RIDGE TOP

FREQUENCY OF HOUSE CLEANING: WEEKLY

TYPE OF VACUUM CLEANER:

FREQUENCY OF COMPLETE HOUSE CLEANING: 1-2 per year

HOW CLEANED? SELF

LAST TIME CLEANED:

DUST RESUSPENSION POTENTIAL: 2
(Rank: 1 high - 5 low)

WOOD STOVE

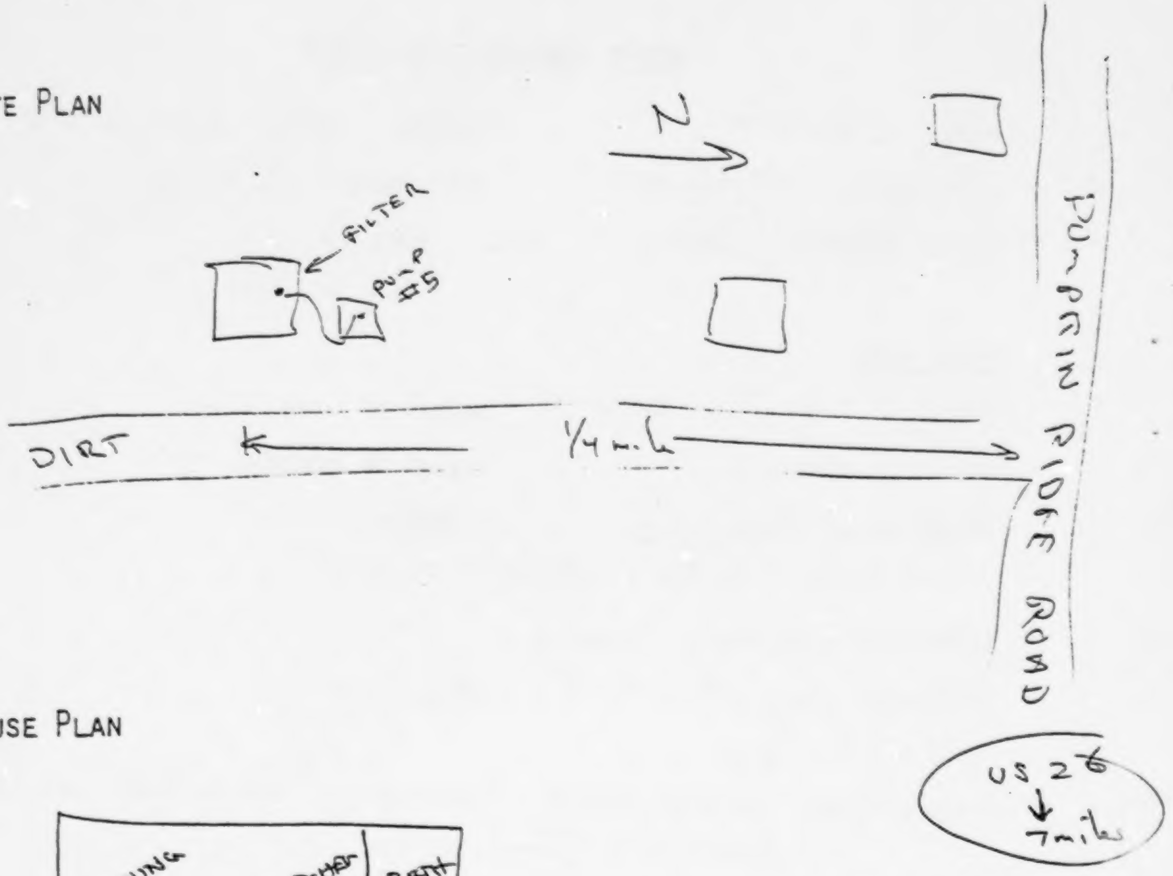
TYPE: ULEFOS AIRTIHT

MODEL: SMALLEST

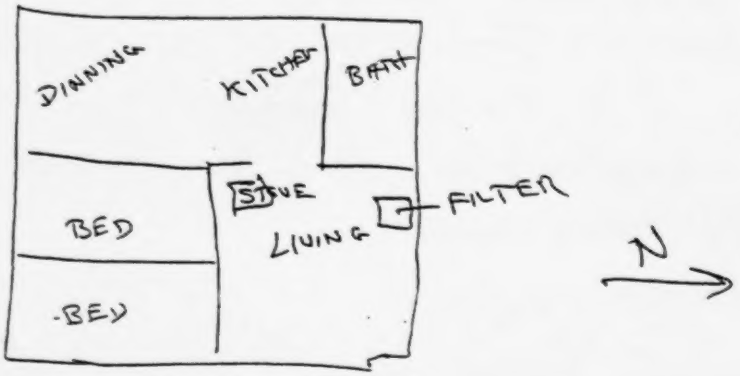
HISTORICAL USE IN HOUSE: INSTALED SEP 1980

USE RELATIVE TO GAS OR ELECTRIC HEAT: 100%

SITE PLAN


FILTER
PUMP #5
N
DIRT
1/4 mile
PUMPKIN RIDGE ROAD
US 26
7 miles

HOUSE PLAN


DINNING
KITCHEN
BATH
STOVE
LIVING
FILTER
BED
BED
N

NOTE WOOD STOVE LOCATION

NOTE FILTER LOCATION

NOTE OTHER HEAT PRODUCING APPLIANCES

DAILY DATA SHEETS

DATE: 5-8-81

FILTER INFORMATION

FILTER NUMBER: OL034

	INITIAL READINGS		INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	8:21 5/8	OUTSID OL033 8:20	10:55 pm	7:42
PRESSURE:	3.0	3.9	2.0	2.0
TEMPERATURE:	58°	475	62	60

WOOD STOVE OPERATION

TIME FIRE STARTED: ________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ________

TOTAL NUMBER OF LOGS USED: ________

APPROXIMATE TIME FIRE ENDED: ________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

MSD NON BURN DAY

POWER FAILURE 1 MIN

DAILY DATA SHEETS

DATE: 5/9/81

FILTER INFORMATION

FILTER NUMBER: 0L035

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/9 7:56	5/9 7:[illegible]	5/10 7:25 am
PRESSURE:	1.4	1.2	1.25
TEMPERATURE:	60	63	59

WOOD STOVE OPERATION

TIME FIRE STARTED: ____________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ____________

TOTAL NUMBER OF LOGS USED: ____________

APPROXIMATE TIME FIRE ENDED: ____________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

SUNNY + WINDY AM

DAILY DATA SHEETS

DATE: 5/10/81

FILTER INFORMATION

FILTER NUMBER: 0L036

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	7:25	7:30	5/11 7:50
PRESSURE:	2.3	0.0/ reset 5.0	5.2
TEMPERATURE:	59	66	61

WOOD STOVE OPERATION

TIME FIRE STARTED: ________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ________

TOTAL NUMBER OF LOGS USED: ________

APPROXIMATE TIME FIRE ENDED: ________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

SUNNY WINDY
HIGHS TO BE IN 65-70
LO 40-45

GRASS CUT

DAILY DATA SHEETS

DATE: 5/11

FILTER INFORMATION

FILTER NUMBER: 0L037

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/11 7:50	9:30	5/12 7:40
PRESSURE:	3.8	4.1	4.1
TEMPERATURE:	61	66	61°

WOOD STOVE OPERATION

TIME FIRE STARTED: ________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ________

TOTAL NUMBER OF LOGS USED: ________

APPROXIMATE TIME FIRE ENDED: ________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SUNNY

SIGNIFICANT AND UNUSUAL EVENTS:

DUSTED & VACUUMED

DAILY DATA SHEETS

DATE: 5/12

FILTER INFORMATION

FILTER NUMBER: DL-038

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/12 7:50	5/12 7:30	5/13 7:40
PRESSURE:	3.6	3.8	3.8
TEMPERATURE:	62°	68°	65

WOOD STOVE OPERATION

TIME FIRE STARTED: ________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ________

TOTAL NUMBER OF LOGS USED: ________

APPROXIMATE TIME FIRE ENDED: ________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SUNNY HIGHS 70'S TONIGHT CLOUDY & COOL

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: 5/14

FILTER INFORMATION

FILTER NUMBER: PL073

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/14 7:40 AM	9:20	7:0
PRESSURE:	3.8	3.9	4.0
TEMPERATURE:	64°	69	60

WOOD STOVE OPERATION

TIME FIRE STARTED: 1:00 pm

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder) SMALL OFF 4:00 P.M.

NUMBER OF TIMES REFUELED: 0

TOTAL NUMBER OF LOGS USED: 8 in

APPROXIMATE TIME FIRE ENDED:

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

RAIN STARTING ≃ NOON

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: 5/15

FILTER INFORMATION

FILTER NUMBER: PL074

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/15 7:40	10:00 pm	7:40
PRESSURE:	4.0	4.0	40
TEMPERATURE:	60°	68	61°

WOOD STOVE OPERATION

TIME FIRE STARTED: 9:00 A.M.

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: 1 time

TOTAL NUMBER OF LOGS USED: 2

APPROXIMATE TIME FIRE ENDED: 9: pm

WEATHER AND EVENTS

OUTSIDE CONDITIONS: mostly clear & sunny

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: 4/16/81

FILTER INFORMATION

FILTER NUMBER: PLO7A b

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	4/16/81 7:50	[illegible]	[illegible]
PRESSURE:	5.0	5.0	[illegible]
TEMPERATURE:	61°	75°	[illegible]

WOOD STOVE OPERATION

TIME FIRE STARTED: 9:30 A.M

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: twice

TOTAL NUMBER OF LOGS USED: 7

APPROXIMATE TIME FIRE ENDED:

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: 6/17/81

FILTER INFORMATION

FILTER NUMBER: DC576

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	6/17 9:45	7:45	5/13 7:45
PRESSURE:	3.0	3.4	35
TEMPERATURE:	65	72°	68°

WOOD STOVE OPERATION

TIME FIRE STARTED: 12:00 & 8 P.M.

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder) even burn

NUMBER OF TIMES REFUELED: 2

TOTAL NUMBER OF LOGS USED: 2

APPROXIMATE TIME FIRE ENDED: 2 a.m.

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

Rain & cool

SIGNIFICANT AND UNUSUAL EVENTS:

DAILY DATA SHEETS

DATE: 5/18/81

FILTER INFORMATION

FILTER NUMBER: P-077

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/18 8.20	1:00 A.M.	5/19 8.45
PRESSURE:	36	3.5	3.6
TEMPERATURE:	69°	62°	60°

WOOD STOVE OPERATION

TIME FIRE STARTED: 8:00 a.m.

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder) one burn

NUMBER OF TIMES REFUELED: ______

TOTAL NUMBER OF LOGS USED: 1/2

APPROXIMATE TIME FIRE ENDED: ?

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

rain

SIGNIFICANT AND UNUSUAL EVENTS:

gone all day

DAILY DATA SHEETS

DATE: 5/19/81

FILTER INFORMATION

FILTER NUMBER: F1078

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/19 900	9:50 PM	5/20 7:15
PRESSURE:	4.0	4.0	4.0
TEMPERATURE:	62	78	66

WOOD STOVE OPERATION

TIME FIRE STARTED: 9:00 A.M

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder) 1 continuous fire

NUMBER OF TIMES REFUELED: 3

TOTAL NUMBER OF LOGS USED: 2

APPROXIMATE TIME FIRE ENDED: ________

WEATHER AND EVENTS

OUTSIDE CONDITIONS: cloudy, mild

SIGNIFICANT AND UNUSUAL EVENTS:

BOOK NUMBER

6

OUTSIDE

LEHD

RESIDENTIAL WOOD COMBUSTION
EMISSIONS TO
INDOOR HAZARDOUS POLLUTION

NEA LABORATORIES, INC.
8310 S.W. Nimbus Avenue
Beaverton, Oregon 97005
643-4661

After Hours
647-2109 D. Joseph
244-8534 J. Houck
646-9306 J. Cooper

C SITE 5

DAILY DATA SHEETS

DATE: 5/8/81

FILTER INFORMATION

FILTER NUMBER: OCC 33

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/8/81 8:20	11:00	8.42
PRESSURE:	3.1	3.8	3.2
TEMPERATURE:	47.5°F	51°F	55

WOOD STOVE OPERATION

TIME FIRE STARTED: ______

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ______

TOTAL NUMBER OF LOGS USED: ______

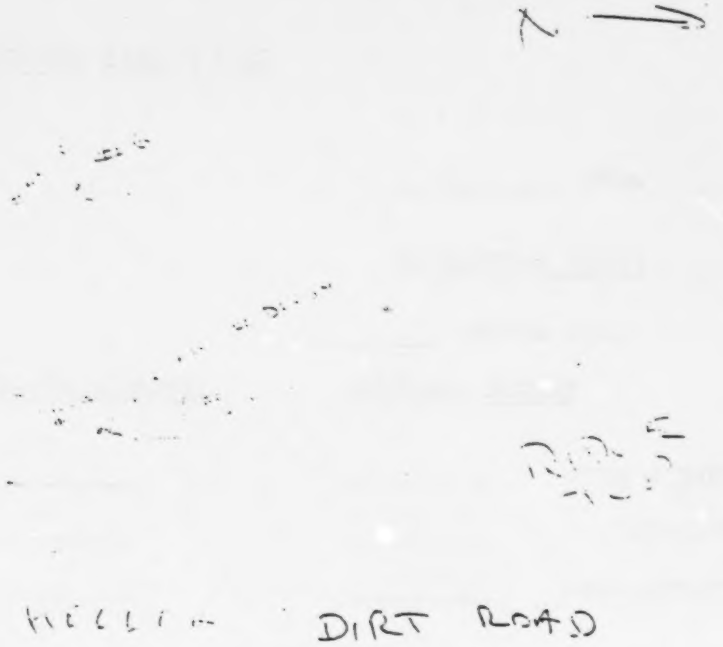
APPROXIMATE TIME FIRE ENDED: ______

WEATHER AND EVENTS

OUTSIDE CONDITIONS:
[illegible] 9:30 [illegible]

SIGNIFICANT AND UNUSUAL EVENTS:

SITE PLAN


N
HILL
DIRT ROAD

HOUSE PLAN

NOTE WOOD STOVE LOCATION
NOTE FILTER LOCATION
NOTE OTHER HEAT PRODUCING APPLIANCES

DAILY DATA SHEETS

DATE: [illegible]

FILTER INFORMATION

FILTER NUMBER: [illegible]

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	[illegible]		[illegible]
PRESSURE:	3.5		[illegible]
TEMPERATURE:	57		53

WOOD STOVE OPERATION

TIME FIRE STARTED: ______

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ______

TOTAL NUMBER OF LOGS USED: ______

APPROXIMATE TIME FIRE ENDED: ______

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

[illegible]

Clear

#4

SITE PLAN

OPEN FIELD

MOBIL HOME

HOUSE PLAN

NOTE WOOD STOVE LOCATION
NOTE FILTER LOCATION
NOTE OTHER HEAT PRODUCING APPLIANCES

SITE [illegible]

DAILY DATA SHEETS

DATE: 5/[illegible]

REDO

FILTER INFORMATION

FILTER NUMBER: DLC16

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	[illegible]		
PRESSURE:	3.2		
TEMPERATURE:	58		

[illegible]

WOOD STOVE OPERATION

TIME FIRE STARTED:

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED:

TOTAL NUMBER OF LOGS USED:

APPROXIMATE TIME FIRE ENDED:

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

[illegible]

SIGNIFICANT AND UNUSUAL EVENTS:

SITE PLAN

~1 Ac LOTS

#2

HOUSE PLAN

NOTE WOOD STOVE LOCATION
NOTE FILTER LOCATION
NOTE OTHER HEAT PRODUCING APPLIANCES

DAILY DATA SHEETS

DATE: [illegible]

FILTER INFORMATION

FILTER NUMBER: [illegible]

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	[illegible]	[illegible]	[illegible]
PRESSURE:	3.6	3 [illegible]	[illegible]
TEMPERATURE:	55	1.4	6[illegible]

WOOD STOVE OPERATION

TIME FIRE STARTED: ____________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ____________

TOTAL NUMBER OF LOGS USED: ____________

APPROXIMATE TIME FIRE ENDED: ____________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

SITE PLAN

#1

HOUSE PLAN

NOTE WOOD STOVE LOCATION
NOTE FILTER LOCATION
NOTE OTHER HEAT PRODUCING APPLIANCES

#2

DAILY DATA SHEETS

DATE: [illegible]

FILTER INFORMATION

FILTER NUMBER: [illegible]

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	[illegible]		[illegible]
PRESSURE:	62		62
TEMPERATURE:	56		57

WOOD STOVE OPERATION

TIME FIRE STARTED: __________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: __________

TOTAL NUMBER OF LOGS USED: __________

APPROXIMATE TIME FIRE ENDED: __________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

TAYLORS FERRY

#3

SITE PLAN

HOUSE PLAN

NOTE WOOD STOVE LOCATION
NOTE FILTER LOCATION
NOTE OTHER HEAT PRODUCING APPLIANCES

#2

DAILY DATA SHEETS

DATE: 5/14/81

FILTER INFORMATION

FILTER NUMBER: 56

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/14 9:45 a	5/14 9:15	8:40 a
PRESSURE:	5.8	5.5	5.4
TEMPERATURE:	57	45	44

WOOD STOVE OPERATION

TIME FIRE STARTED: ________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ________

TOTAL NUMBER OF LOGS USED: ________

APPROXIMATE TIME FIRE ENDED: ________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

SITE PLAN

SITE #2

HOUSE PLAN

NOTE WOOD STOVE LOCATION
NOTE FILTER LOCATION
NOTE OTHER HEAT PRODUCING APPLIANCES

DAILY DATA SHEETS

SITE #2

DATE: 5/15/81

FILTER INFORMATION

FILTER NUMBER: DLC.54

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/15 9:35	[illegible]	5/16 [illegible]
PRESSURE:	3 3	[illegible]	3.3
TEMPERATURE:	45	[illegible]	50°

WOOD STOVE OPERATION

TIME FIRE STARTED: ____________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ____________

TOTAL NUMBER OF LOGS USED: ____________

APPROXIMATE TIME FIRE ENDED: ____________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

SITE PLAN #2

HOUSE PLAN

NOTE WOOD STOVE LOCATION
NOTE FILTER LOCATION
NOTE OTHER HEAT PRODUCING APPLIANCES

DAILY DATA SHEETS #2

DATE: 5/16

FILTER INFORMATION

FILTER NUMBER: DL049

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/16 9:50 am	5/16 7:45 pm	[illegible]
PRESSURE:	-4.8	-4.75	-4.7
TEMPERATURE:	50°F	54°F	48°F

WOOD STOVE OPERATION

TIME FIRE STARTED: __________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: __________

TOTAL NUMBER OF LOGS USED: __________

APPROXIMATE TIME FIRE ENDED: __________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

SITE PLAN

#2

HOUSE PLAN

NOTE WOOD STOVE LOCATION
NOTE FILTER LOCATION
NOTE OTHER HEAT PRODUCING APPLIANCES

DAILY DATA SHEETS

#2

DATE: 5/17/81

FILTER INFORMATION

FILTER NUMBER: DL090

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	5/17 7:00 am		5/18 9:45 am
PRESSURE:	3.2	-3.2	[illegible]
TEMPERATURE:	48°F	53°F	56°F

WOOD STOVE OPERATION

TIME FIRE STARTED: ________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ________

TOTAL NUMBER OF LOGS USED: ________

APPROXIMATE TIME FIRE ENDED: ________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

SITE PLAN

HOUSE PLAN

NOTE WOOD STOVE LOCATION
NOTE FILTER LOCATION
NOTE OTHER HEAT PRODUCING APPLIANCES

DAILY DATA SHEETS #2

DATE: 5/18/81

FILTER INFORMATION

FILTER NUMBER: DL089

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	[illegible] am	5/18 9:20 pm	5/19 7:40 am
PRESSURE:	[illegible]	-4.2	-4.2
TEMPERATURE:	[illegible]	50°F	48°F

WOOD STOVE OPERATION

TIME FIRE STARTED: ____________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ____________

TOTAL NUMBER OF LOGS USED: ____________

APPROXIMATE TIME FIRE ENDED: ____________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

SITE PLAN

HOUSE PLAN

NOTE WOOD STOVE LOCATION
NOTE FILTER LOCATION
NOTE OTHER HEAT PRODUCING APPLIANCES

DAILY DATA SHEETS

DATE: __________

FILTER INFORMATION

FILTER NUMBER: __________

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	__________	__________	__________
PRESSURE:	__________	__________	__________
TEMPERATURE:	__________	__________	__________

WOOD STOVE OPERATION

TIME FIRE STARTED: __________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: __________

TOTAL NUMBER OF LOGS USED: __________

APPROXIMATE TIME FIRE ENDED: __________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

Site Plan

House Plan

NOTE WOOD STOVE LOCATION
NOTE FILTER LOCATION
NOTE OTHER HEAT PRODUCING APPLIANCES

DAILY DATA SHEETS

DATE: ____________

FILTER INFORMATION

FILTER NUMBER: __________

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	__________	__________	__________
PRESSURE:	__________	__________	__________
TEMPERATURE:	__________	__________	__________

WOOD STOVE OPERATION

TIME FIRE STARTED: ____________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ____________

TOTAL NUMBER OF LOGS USED: ____________

APPROXIMATE TIME FIRE ENDED: ____________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

Site Plan

House Plan

NOTE WOOD STOVE LOCATION
NOTE FILTER LOCATION
NOTE OTHER HEAT PRODUCING APPLIANCES

DAILY DATA SHEETS

DATE: ____________

FILTER INFORMATION

FILTER NUMBER: _________

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	__________	__________	__________
PRESSURE:	__________	__________	__________
TEMPERATURE:	__________	__________	__________

WOOD STOVE OPERATION

TIME FIRE STARTED: ____________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ____________

TOTAL NUMBER OF LOGS USED: ____________

APPROXIMATE TIME FIRE ENDED: ____________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

SITE PLAN

HOUSE PLAN

NOTE WOOD STOVE LOCATION
NOTE FILTER LOCATION
NOTE OTHER HEAT PRODUCING APPLIANCES

DAILY DATA SHEETS

DATE: ____________

FILTER INFORMATION

FILTER NUMBER: __________

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	__________	__________	__________
PRESSURE:	__________	__________	__________
TEMPERATURE:	__________	__________	__________

WOOD STOVE OPERATION

TIME FIRE STARTED: ____________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ____________

TOTAL NUMBER OF LOGS USED: ____________

APPROXIMATE TIME FIRE ENDED: ____________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

SITE PLAN

HOUSE PLAN

NOTE WOOD STOVE LOCATION
NOTE FILTER LOCATION
NOTE OTHER HEAT PRODUCING APPLIANCES

DAILY DATA SHEETS

DATE: ____________

FILTER INFORMATION

FILTER NUMBER: _________

	INITIAL READINGS	INTERMEDIATE READINGS	FINAL READINGS
TIME & DATE:	__________	__________	__________
PRESSURE:	__________	__________	__________
TEMPERATURE:	__________	__________	__________

WOOD STOVE OPERATION

TIME FIRE STARTED: ____________

DESCRIPTION OF FIRE: (e.g., hot start-up, then smolder)

NUMBER OF TIMES REFUELED: ____________

TOTAL NUMBER OF LOGS USED: ____________

APPROXIMATE TIME FIRE ENDED: ____________

WEATHER AND EVENTS

OUTSIDE CONDITIONS:

SIGNIFICANT AND UNUSUAL EVENTS:

	HOUSE	BUNDLE	WT
SITE PLAN	I	~~26~~	98
		27 ✓	120
		28	101
		29 ✓	73
		30 PARTIAL	87
		31 ✓	82
		32 ✓	94
		34	68
	V		
HOUSE PLAN	F	~~120~~	
		~~97~~	
	2	33 ✓	120
		35	97
		36	93 PARTIAL = 52#
		37 ✓	95
		38 ✓	79
		39	77
		40 ✓	72
		41 ✓	77

TOTAL WT 723

TOTAL WT 710

NOTE WOOD STOVE LOCATION
NOTE FILTER LOCATION
NOTE OTHER HEAT PRODUCING APPLIANCES

RWEEP

Task 7 Raw Data

Part 3

Home #1 (No Burning)

Filter	Net Weight	
1	3.422 mg	
2	6.978 mg	
3	6.085 mg	7.4% correction
4	5.343 mg	
5	2.609 mg	
Total	24.437 mg + 1.82 mg* ÷ 519.6 m^3 = 50.5 µg/m^3	

Home #1 (Burning)

Filter	Net Weight	
1	8.800 mg	
2	3.883 mg	
3	7.905 mg	5.1% correction
4	7.177 mg	
5	7.479 mg	
Total	35.244 mg + 1.82 mg* ÷ 503.5 m^3 = 73.6 µg/m^3	

Home #2 (No Burning)

Filter	Net Weight	
1	2.092 mg	
2	0.591 mg	5.1 % correction
3	0.225 mg	
Total	2.908 mg + 1.092 mg* ÷ 241.8 = 16.5 µg/m^3	

Home #2 (Burning)

Filter	Net Weight	
1	2.830 mg	
2	2.180 mg	
3	1.780 mg	18.1% correction
4	1.397 mg	
5	1.947 mg	
Total	10.134 mg + 1.82 mg* ÷ 519.8 m^3 = 23.0 µg/m^3	

Home #3 (No Burning)

Filter	Net Weight	
1	2.517 mg	
2	3.157 mg	
3	0.713 mg	22.4% correction
4	0.396 mg	
5	1.31 mg	
Total	8.093 mg + 1.82 mg* ÷ 528.5 m^3 = 18.7 µg/m^3	

Home #3 (Burning)

Filter	Net Weight	
1	1.883 mg	
2	1.324 mg	
3	0.841 mg	22.5% correction
4	2.145 mg	
5	1.872 mg	
Total	8.065 mg + 1.82 mg* ÷ 506.2 m^3 = 19.5 µg/m^3	

* Correction to account for lost quart filters on filter holder gasket.

RWEEP

Task 7 Raw Data

Part 3 - Continued

Home #4 (No Burning)

Filter	Net Weight	
1	3.669 mg	
2	VOID	
3	2.697 mg	12% correction
4	1.490 mg	
5	4.161 mg	
Total	12.017 mg + 1.45 mg* ÷ 409.8 m^3 = 32.9 µg/m^3	

Home #4 (Burning)

Filter	Net Weight	
1	4.954 mg	
2	5.650 mg	
3	2.555 mg	9.7% correction
4	2.735 mg	
5	2.499 mg	
Total	18.388 mg + 1.799 mg* ÷ 523.3 m^3 = 39.6 µg/m^3	

Home #5 (No Burning)

Filter	Net Weight
1	VOID
2	-
3	VOID
4	VOID
5	-

Home #5 (Burning)

Filter	Net Weight	
1	8.398 mg	
2	7.438 mg	
3	7.197 mg	6.3% correction
4	VOID	
5	6.109 mg	
Total	29.142 mg + 1.84 mg* ÷ 400.4 m^3 = 77.4 µg/m^3	

* Correction to account for lost quart filters on filter holder gasket.

Bank filter weights before & after loading

.327 mg	.355 mg	.368 mg	.414 mg
.220 mg	.122 mg	.196 mg	.689 mg
.614 mg	.108 mg	.958 mg	
.238 mg	-.344 mg	.397 mg	
.507 mg	.371	.640 mg	

$\underline{N}$ = 17
$\bar{X}$ = 0.367 ± 0.285 std. dev.

Correction = 0.367 mg/filter for 5 filters,
correction = 1.82 mg